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ELECTROMAGNETIC COMPATIBILITY MANUAL. APPENDIX A THROUGH APPENDIX G

Naval Air Systems Command
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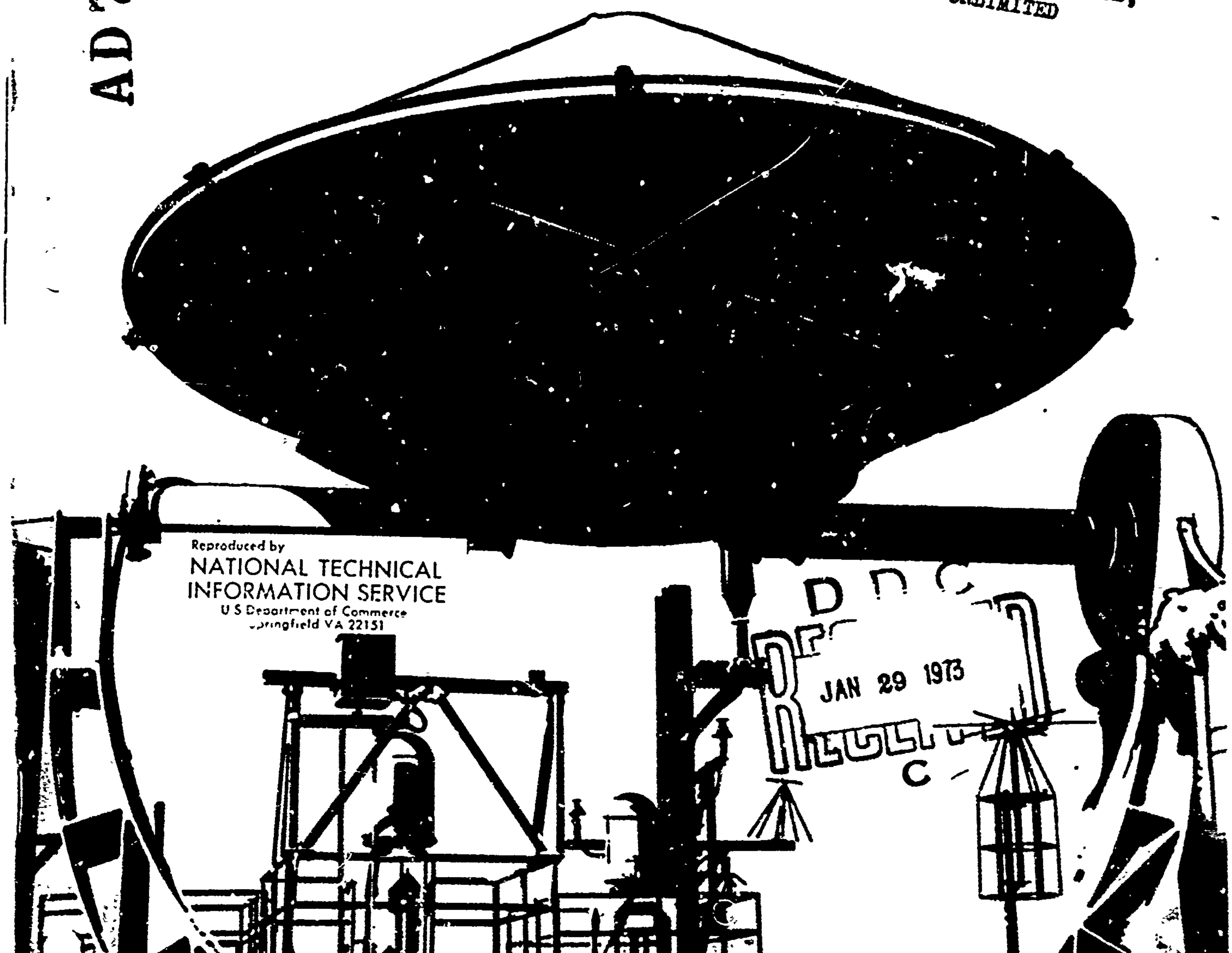
NAVAIR 5335

NAVAL AIR SYSTEMS COMMAND

ELECTROMAGNETIC COMPATIBILITY MANUAL

MAY 1972



PUBLISHED BY DIRECTION OF COMMANDER, NAVAL AIR SYSTEMS COMMAND

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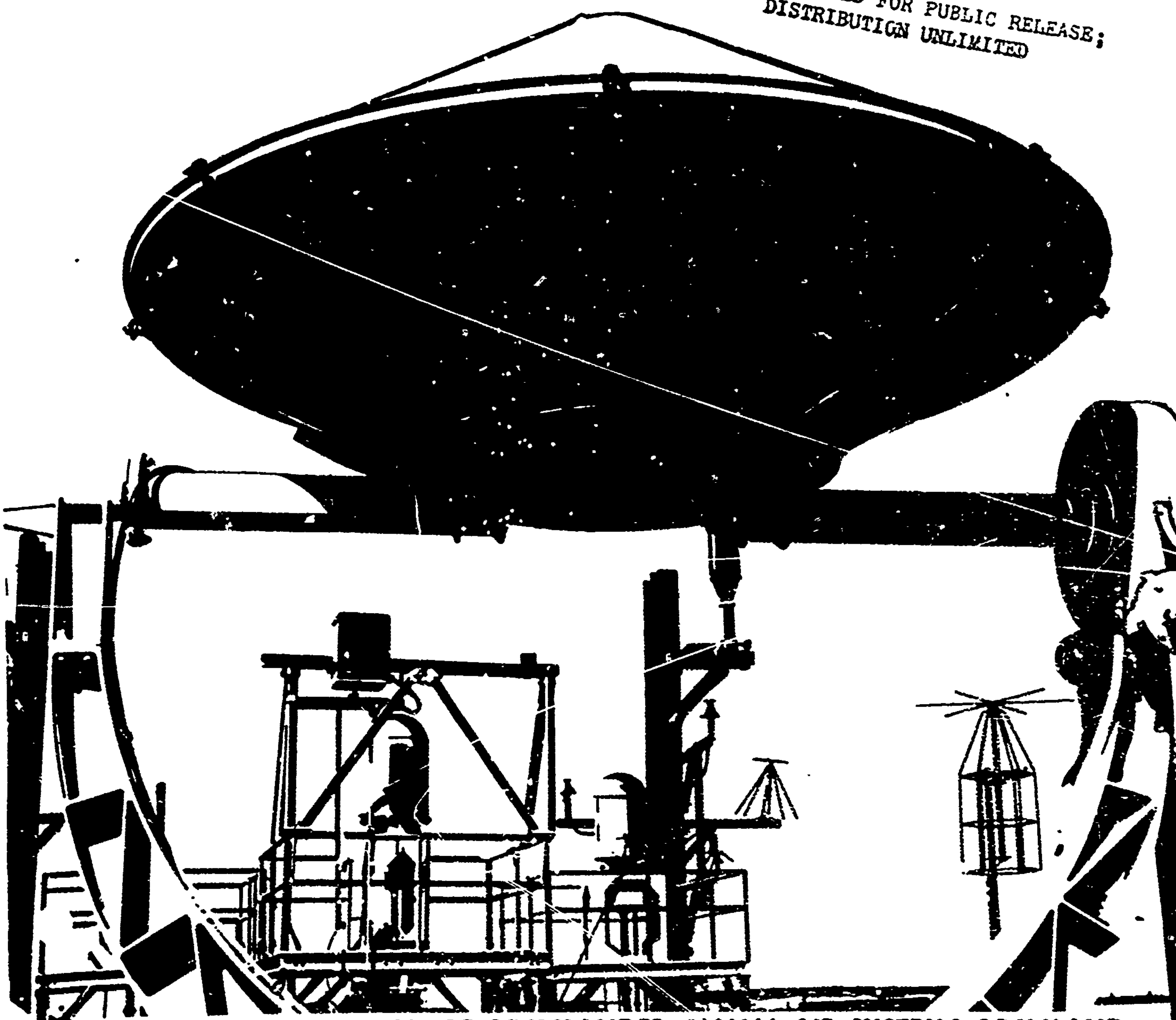
ELECTROMAGNETIC COMPATIBILITY MANUAL

APPENDIX A

SAMPLE EMC CONTROL PLAN FOR A WEAPON SYSTEM



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APPENDIX A
SAMPLE EMC CONTROL PLAN FOR A WEAPON SYSTEM

PREFACE

The EMC Control Plan included here is an example of the control plan of a large aircraft weapon system. It can be used as a model for the development of a control plan for a similar or smaller system by appropriate abbreviation and modification. A Control Plan of this type must be provided when a procurement contract calls for compliance with the requirements of MIL-E-6051 – Electromagnetic Compatibility Requirements, Systems. This specification lists the subjects to be covered in the Control Plan and describes both management and technical controls that will be used by the contractor to assure EMC of the system.

The Control Plan should consist of a basic plan with supplemental exhibits as required. The basic Control Plan should describe the management plan for the contractor's EMC program and the technical approach that will be used to achieve system compatibility. There must also be a discussion of EMC subjects listed in MIL-E-6051D. Several of these are: atmospheric phenomena, such as precipitation static and lightning; flight safety; personnel hazards; and electromagnetic hazards pertinent to ordnance and to the external environment. A discussion of testing should include verification of design as well as tests related to the quality assurance program. Exhibits should include such things as the charter for the EMC Advisory Board, exceptions to MIL-E-6051 (or other EMC specifications and standards), associated programs and specifications, and a description of the contractor's EMC test facilities.

Each EMC Control Plan must be tailored to meet the requirements peculiar to each specific contract. This will generally result in certain exceptions to the requirements of the system EMC specification. These exceptions must be thoroughly documented in the Control Plan. The management of the contractor's EMC program may differ from that described in the sample Control Plan and must be organized to fit the contractor's overall management scheme. The contractually invoked specifications for interference control, bonding, wiring separation, and shield grounding may require modification to apply to each contract, but in general all requirements of these documents must be met. Modification in the form

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of additional contractor specifications to conform to the contractor's normal operating procedures may be required, but these documents should not supersede or waive any requirements of contractually invoked specifications or standards but should further aid in their intent.

This model Control Plan contains amendments to the military specification MIL-E-6051D. These are not contractually effective or binding because of their inclusion in the Control Plan. To be contractually effective and binding they must be submitted as a deviation and must be approved through the procedures established for processing requests for deviations under the specific type of contract involved. Reference is made to NAVAIR Instruction 4355.9.

The sample Control Plan will furnish at least a model framework for the preparation of a new Control Plan. It will usually furnish more than this because new weapon systems will normally have many features in common with those of the sample EMC Control Plan. To avoid the necessity of classifying this document, the performance figures (frequencies, power, sensitivity) given in this sample Control Plan are not realistic and do not apply to particular equipments.

WANDOW AIRCRAFT ENGINEERING CORPORATION

PLYMOUTH, PA.

ELECTROMAGNETIC COMPATIBILITY CONTROL PLAN

FOR

XY-1A WEAPON SYSTEM

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WANDOW AIRCRAFT ENGINEERING CORPORATION

PLYMOUTH, PA.

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Report No. BP51-690-XY

Release Date 6 March 19XX

ELECTROMAGNETIC COMPATIBILITY CONTROL PLAN

FOR

XY-1A WEAPON SYSTEM

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1.0 Scope

1.1 General

This Control Plan delineates the system Electromagnetic Compatibility (EMC) Program for the XY-1A weapon system ~~as required by paragraph~~ 3.3 of Specification MIL-E-6051D. This program description includes management policy and organization, technical requirements, test program and documentation requirements. The purpose of this program is to produce an electromagnetically compatible, integrated weapon system.

2.0 Applicable Documents

2.1 Effectiveness of Documents

The following documents of the issue in effect on October 1, 19XX, unless otherwise noted, form a part of this document to the extent specified herein.

Specifications – Military

MIL-B-5087B	Bonding, Electrical, and Lightning Protection, For Aerospace Systems
MIL-W-5088C	Wiring, Aircraft, Installation Of
MIL-E-6051D	Electrical-Electronic System Compatibility and Interference Control Requirements For Aeronautical Weapon System, Associated Subsystems and Aircraft
MIL-F-15733E	Filters, Radio Interference, General Specifications For
MIL-P-24014	Preclusion of Hazards from Electromagnetic Radiation to Ordnance, General Requirements For
MIL-D-8706B	Data and Tests, Engineering; Contract Requirements
MIL-D-8708A	Demonstration Requirements for Airplanes

Standards – Military

MIL-STD-449C	Radio Frequency Spectrum Characteristics, Measurement Of
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-463	Definitions and Systems of Units, Electromagnetic Interference Technology
MIL-STD-469	Radar Engineering Design Requirements, Electromagnetic Compatibility
MIL-STD-704	Electric Power, Aircraft, Characteristics and Utilization Of
MIL-STD-461A	Electromagnetic Interference Characteristics, Requirements For Equipment

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MIL-STD-462	Electromagnetic Interference Characteristics, Measurement Of

Specifications – Contractor

SPECEL300 1-14-XX	Electrical Bonding Requirements, General Specification For, XY-1A Weapon System
SPECEL200 2-4-XX	Electromagnetic Compatibility, Wiring Separation, and Shield Grounding, Requirements For, XY-1A Weapon System
SPECSE016 11-8-XX	Electromagnetic Interference Control Requirements For Sellers, General Specification For, XY-1A Weapon System

Aeronautical Requirements

XY-692	XY-1A Aircraft Weapon System Design Specification
AR-43	Electromagnetic Compatibility Advisory Board, Requirements For
AR-29	Electromagnetic Compatibility, Frequency Allocation, and Spectrum Signature

Charter – Contractor (WANDOW)

CHARTER-R-XX 3-6-XX	Charter for Electromagnetic Compatibility Advisory Board (EMCAB)

3.0 Requirements

3.1 Management Approach to EMC

To insure implementation of all EMC design, test, and documentation requirements for the XY-1A weapon system, a distinct EMC group has been organized within the XY-1A Systems Group. The duties and authority of the EMC Group are clearly defined using a work package (task) management concept.

3.1.1 EMC Organization

Figure 1 illustrates the basic EMC Group organization relative to the XY-1A Project and the RF Engineering Section. The XY-1A Group Leader, who is systems oriented, reports to a Senior Group Leader for Systems Integration, who is in turn responsible to the XY-1A Systems Project Engineer. The Systems and Electronic Design (subsystem) Project Engineers are responsible for all XY-1A weapons systems tasks related to electronics or electronic equipment. Technical engineering responsibility for all EMC efforts rests with a Group Head (or his designee) within the RF Engineering Section. The Group Head will be available for technical consultation, assistance on special problems, and will closely monitor the activities of the XY-1A EMC Group, providing guidance and supervision as necessary.

3.1.2 Responsibilities and Authority of the XY-1A EMC Group

To insure completion and total integration of the overall EMC effort on the XY-1A Program, each EMC task has been assigned to a specific sub-group within the EMC Group. The tasks assigned are divided into systems analysis, systems test, vehicle design, and subsystems categories.

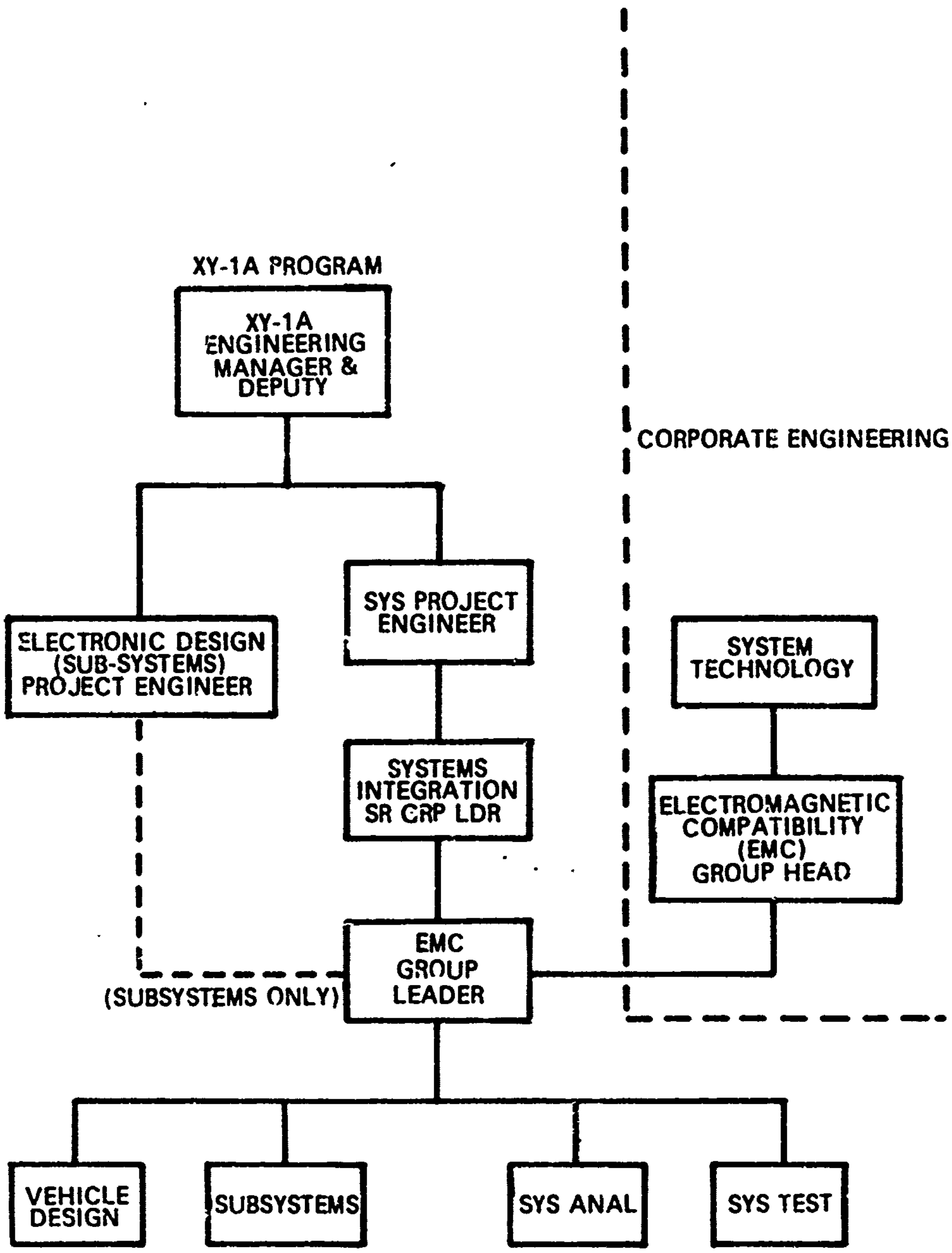

FIGURE 1 XY-1A EMC ORGANIZATION

Wandow Aircraft Engineering, corp.
Plymouth, Pa.

3.1.2.1 System Analysis Tasks

The following tasks and extent of authority are assigned to the System Analysis Sub-Group:

Prepare this EMC Control Plan – approval required by XY-1A project, EMC Group, and RF Section.

Prepare agenda for EMCAB, chair EMCAB meetings, and coordinate with members; prepare and distribute report.

Perform analysis between Comm/Nav, WCS, and ECM and prepare report – approval required by the XY-1A project, EMC Group and RF Section.

Define solutions for analysis problems in terms of filtering, blanking, frequency assignment, or time assignment.

Evaluate hardware for EMC solutions – approval required for seller selection.

Define solutions for EMI problems related to GFE modifications. Make recommendations to customer and coordinate problem solutions.

Define CFE and GFE requirement to achieve aircraft/CFE equipment compatibility – EMC Group review and approval required of all electrical/electronic equipment specifications.

Establish liaison with major GFE sellers (JSH Inc., JJF Indust., KLH Corp.) for exchange of data for EMC analysis.

Perform radiation hazard (RADHAZ) analysis for ordnance, personnel, fuel, EEDS, and prepare RADHAZ Report – approval required by the XY-1A Project, EMC Group, and RF Section.

3.1.2.2 System Test Tasks

The following tasks and extent of authority are assigned to the System Test Sub-Group.

Perform engineering evaluation shielded room tests on selected equipment to supplement analysis of emission and susceptibility predicted problems. Facilities are allocated for this task.

Monitor implementation of System Test Simulation Laboratory (STSL) tests. Perform STSL tests to verify braided harness configurations effects, assure subsystem interface compatibility, verify EMC analysis. Resident EMC engineer to be stationed at STSL area.

Prepare plans and procedures for Systems Test Simulation.

Prepare aircraft Safety of Flight Test (SOFT) procedure – approval required by XY-1A Project, EMC Group, and RF Section.

Monitor aircraft SOFT and prepare EMC SOFT Report – approval required by XY-1A Project, EMC Group, and RF Section.

Prepare RADHAZ Test Procedure – approval required by XY-1A Project, EMC Group, and RF Section.

Monitor RADHAZ test of aircraft and prepare RADHAZ Report – approval required by XY-1A Project, EMC Group, and RF Section.

Prepare aircraft functional compatibility test plan and procedures – approval required by XY-1A Project, EMC Group, and RF Section.

Monitor aircraft functional compatibility test and prepare test report – approval required by XY-1A Project, EMC Group, and RF Section.

Recommend aircraft design modifications for specification compliance.

3.1.2.3 Vehicle EMC Design Tasks

The following tasks and extent of authority are assigned to the Vehicle Design Sub-Group:

Prepare Vehicle Electrical Bonding Design information for design groups – approval of Vehicle Bonding Specification required by XY-1A Project, EMC Group, and RF Section.

Monitor implementation of Bonding and Lightning Protection Design – review of drawings of electrical/electronic equipment installations required.

Determine P-static discharger requirements and specify to design groups – review of installation drawings required.

Prepare work statement, evaluate proposal and negotiate contract with Lightning Study Subcontractor – approval of XY-1A Project, EMC Group, and RF Section.

Analyze equipment locations and recommend optimum EMC layout.

Provide vehicle EMC wiring provision information (separation, shielding, special requirements) – approval of vehicle EMC Wiring Specification by XY-1A Project, EMC Group, and RF Section.

Review Weapon System Wiring Diagram for incorporation of EMC requirements, (including EED requirements) – approval of review of all wiring diagrams by XY-1A EMC Group is required.

Monitor EMC cable routing in mock-up and prototype aircraft.

Perform electrical bonding measurements on aircraft and prepare Electrical Test Bonding Report – approval of XY-1A Project, EMC Group, and RF Section.

Review implementation of aircraft configuration changes for RADHAZ correction, specification compliance, bonding correction, lightning protection recommendations, or other modifications – approval of Engineering Orders (EOS) by the XY-1A EMC Group is required.

3.1.2.4 Subsystem EMC Tasks

The following tasks and extent of authority are assigned to the subsystem EMC Sub-Group:

Evaluate sellers proposals (including EMI Control Plans) and negotiate with sellers to obtain proposal clarifications and EMI Control Plan corrections – Control Plans must be approved by the XY-1A EMC Group prior to purchase order for equipment.

Participate in periodic design reviews with seller – authorized by EMI sellers requirements document SPECSE016 and general sellers requirements document.

Review and approve sellers documentation for EMI analysis, test plans, and test reports – authorized by EMI sellers requirements document SPECSE016 and general sellers requirements document.

Assess EMI test facilities and monitor sellers EMI tests – authorized by general sellers requirements document and performance specification.

Provide EMI specification deviations to systems analysis group for evaluation – the XY-1A EMC Group must approve EMI specification deviations.

3.1.3 Liaison between EMC Group and Wandow Departments

To insure the inclusion of desirable EMC features in Vehicle Design while maintaining drawing release and hardware fabrication schedules, an information flow system has been established as shown in Figures 2 and 3. This system has proved effective on the Navy XX-11B Program. An information flow system has also been established for lightning protection as shown in Figure 4.

3.1.4 EMC Liaison with GFE Suppliers

A proper liaison has been established between major GFE sellers as follows: JSH, AWG-0 and AIM-00; JJF Indust., AIR-0E and AIM-0F; KLH Corp., ALQ-000. JSH Inc. and JJF Indust. will be represented on the EMCAB (AR-43). Lines of communication have been established to insure timely, correct interpretation of EMC requirements contained in the Performance and Interface (P & I) Specifications, transmittal of all EMC installation provision information (shielding, bonding, wiring separation, grounding) mutual cooperation in resolving EMC problems related to GFE, definition of parameters needed for external EMC analysis, transmittal of equipment operational directions for test procedure generation, and support of GFE equipment during test programs.

3.1.5 Subcontractor EMI Program

To achieve the degree of electromagnetic interference control of CFE subsystems necessary for overall system compatibility, Wandow has established a comprehensive EMI Control Program for all sellers of electronic/electrical equipment. In addition to the EMI technical requirements contained in each equipment performance specification, each seller must meet the requirements of specification SPECSE016. This document is contained in Exhibit A. The program described in the specification places proper emphasis on EMI considerations early in the equipment development program through frequent design reviews with Wandow, EMI analysis with supporting documentation, and prequalification EMI developmental tests. To insure the consideration of EMI from the very beginning of equipment design and development, the seller's EMI Control Plan must be submitted as a part of the proposal and approved

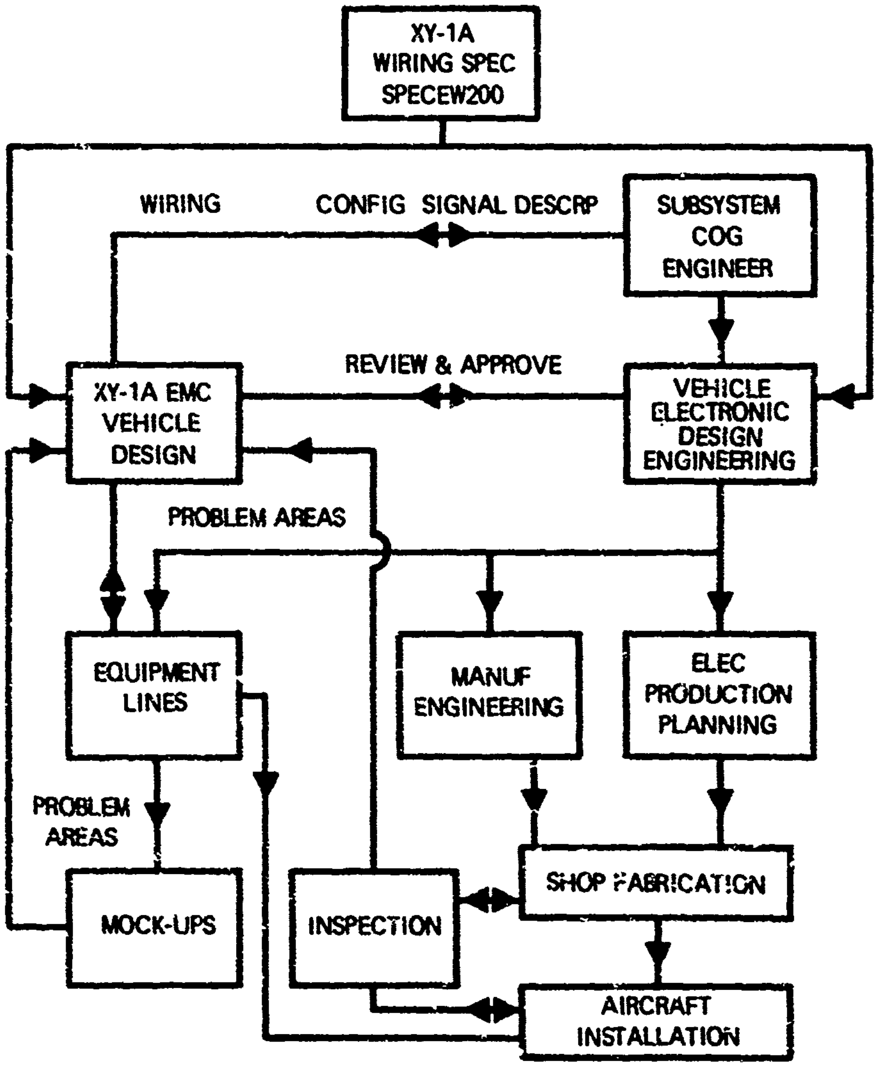

FIGURE 2 WANDOW FLOW CHART, WIRING, XY-1A EMC

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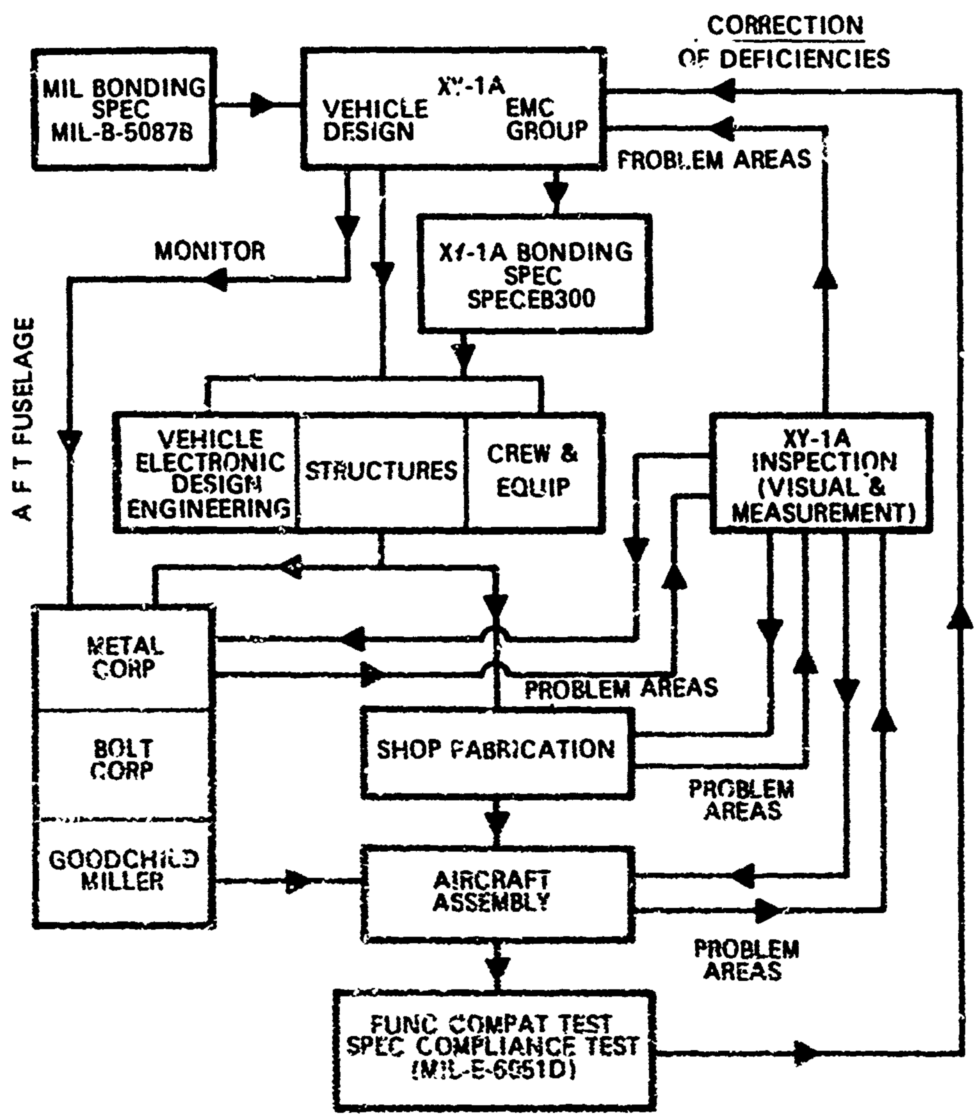

FIGURE 3 WANDOW FLOW CHART, ELECTRICAL BONDING, XY-1A

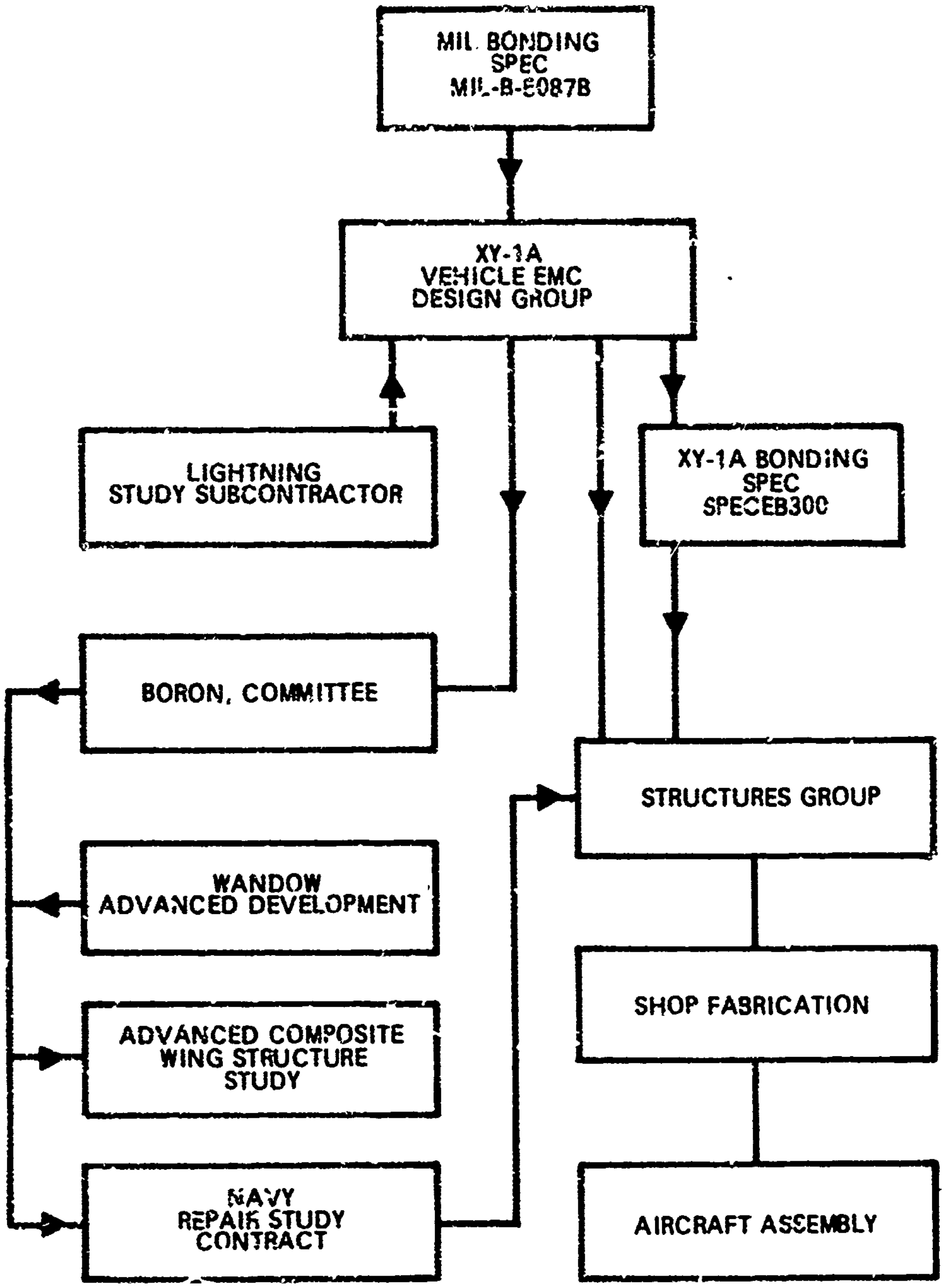

FIGURE 4 WANDOW FLOW CHART, LIGHTNING PROTECTION, XY-1A

prior to award of contract. Figure 5 illustrates the subsystem EMC Data Status Sheet used to compare program data status versus scheduled milestones. The seller facility will be visited by an EMC engineer on a regular basis for participation in design reviews, inspection of EMI test facility, monitoring of EMI test, and resolution of EMI problems.

3.1.6 Electromagnetic Compatibility Advisory Board

To identify potential EMC problems, especially in regard to joint Navy/Wandow responsibilities, and to recommend means of resolution, an Electromagnetic Compatibility Advisory Board (EMCAB) has been established. The charter is contained in Exhibit B. The formation and operation of the EMCAB and the preparation of its charter will be in accordance with the requirements of AR-43 (Electromagnetic Compatibility Advisory Board, Requirements for) and the requirements of paragraph 3.1.1 of Specification MIL-E-6051D (Electromagnetic Compatibility Requirements, Systems).

3.2 EMC Program Requirements

The XY-1A Weapon System shall be designed to be electromagnetically compatible in accordance with MIL-E-6015D as modified by Wandow standard exceptions listed in Exhibit C. Subsystems shall be designed and qualified to the requirements of MIL-STD-461A as augmented by Wandow to achieve compatibility as required by 3.2.4.1, 3.4 and 3.5 of MIL-E-6051D.

3.2.1 System Requirements

3.2.1.1 Electrical Bonding

Electrical bonding, to establish an equipotential structure, to provide for current return, and to provide electrical stability so that installations are free from the hazards of lightning, static discharge, and electrical shock shall be in accordance with MIL-B-5087. Wandow XY-1A Bonding Specification SPECEB300, contained in Exhibit A, shall be used to supplement MIL-B-5087 for vehicle electrical bonding. Special attention shall be given to antenna counterpoise bonding, treatment of boron composite structures, mating of titanium parts, dissimilar metal assemblies and protection against corrosion.

3.2.1.2 Precipitation – Static Control

Precipitation static will be controlled, if necessary for UHF communications, by the use of decoupled "null field" precipitation static dischargers. It is not anticipated that the XY-1A variable wing geometry will present any unusual problems in mounting dischargers. Special attention will be directed to appropriate resistance coating on plastic surfaces such as radomes, to prevent static build-up and corona discharge.

3.2.1.3 Lightning Protection

Specifications MIL-B-5087 and SPECEB300 shall be adhered to for lightning protection provisions. Special attention shall be directed to protecting boron composite structure. The need for techniques of post-lightning strike repair for boron structure will be studied. Externally exposed plastic sections such as canopies, radomes, and fairings will be protected, if area and geometry warrant protection, by metallic strips having a cross-section of at least 40,000 circular mils. It is not anticipated that the flush mounted antenna structures will be vulnerable to lightning strikes. Blade type antennas will be protected by the bonding techniques specified for normal antenna installation. The vertical fin

EMC APPROVAL/INFO.	NAVY WAEC	APP APP	NR INFO	NR INFO	NR INFO	NR INFO	NR INFO	NR INFO	NR INFO	NR INFO	NR INFO	NR APP	APP APP	APP APP
MILESTONE SCHEDULE		PROPOSAL	60 ARO	120 ARO	180 ARO	DESIGN REV	10 PTR	15 AR	10 PTT	30 AT	ON OCCURENCE	120 PTT	60 PTT	30 AT
SELLER RECT ITEM NUMBER			[illegible]	E21A02	E24A02	E2/B02	[illegible]	[illegible]	301A01	3?1A01	E22A??	T01A01	T02A02	T03A01
DOCUMENT SUBSYSTEM/SELLER	CON ENG.	[illegible]	[illegible] ANAL	[illegible] ANAL	FAILURE EFFECT ANAL	INTERFACE CONTROL DOC	DESIGN REV PACKAGE	DESIGN REV REPORT	DEVEL. TEST PLAN	DEVEL. TEST REPORT	FAILURE ANAL	QUAL. T.P. PRELIM.	QUAL. T.P. FINAL	QUAL. TEST REPORT

ARO = AFTER RECEIPT OF ORDER, PTR = PRIOR TO REVIEW, AR = AFTER REVIEW, PTT = PRIOR TO TEST, AT = AFTER TEST, NR = NOT REQUIRED.

FIGURE 5 XY-1A SUBSYSTEM EMC CFE DATA STATUS will be protected by metal strips 0.090 X 0.440 inches in cross-section adequately bonded to airframe structure.

The rotating wing joint and horizontal stabilizer pivot bearing will incorporate inherent electrical bonding similar to the successful XX-11 design. Application of specification bonding techniques to fuel system plumbing, fuel access doors, fuel dump fixtures, and tank components will insure maximum protection of the fuel system. A study of lightning protection will be made by a subcontractor specializing in lightning discharge phenomenon. Recommendations by the subcontractor from analysis and test will be implemented in the vehicle design. General Electric and Lightning and Transients Research Institute are being considered for this study.

3.2.1.4 Wiring, Grounding and Shielding

Separation of cabling into compatible categories reduces interference coupling from subsystem to subsystem. Specification SPECEW200, contained in Exhibit A, defines wiring separation and shield grounding techniques for the XY-1A vehicle. Shielding methods will also be reviewed relative to special requirements such as MIL-F-24014 for EED protection.

3.2.1.5 Locations of Equipment

The physical location of equipment will be based on anticipated emission and susceptibility characteristics of individual equipments and minimization of unit to unit cabling lengths. Particular attention is directed to ensure that vehicle electronic design junction boxes and control panels use appropriate EMC design techniques to reduce interference effects between subsystems. The features incorporated into these designs include: wiring separation techniques, relay coil suppression, switch suppression, transformer isolation, and grounding techniques.

3.2.1.6 EMC Flight Safety

Particular attention will be given to areas of EMC that affect safety of personnel, crew, aircraft, carrier, or property. Susceptibility immunity of the automatic flight control system has been shown to be of vital importance to flight safety of the aircraft. Susceptibility immunity of the armament control system to inadvertent stores release is essential for safety of ground, carrier, and crew personnel.

3.2.1.7 Microwave Radiation Hazards

Hazards that exist due to AWG-0 radar radiation will be defined. Where possible without compromising fundamental AWG-0 performance, hazards can be reduced in the design of the forward aircraft bulkhead by application of shielding or microwave-absorptive material. RF sealing of bulkhead openings and use of filter pin connectors are anticipated. Hazards that cannot be reduced by reduction of radiation levels will be referred to the Wandow XY-1A Safety Group for consideration. Radiation-prevention interlocks may be required for ground operation.

3.2.1.7.1 Personnel Safety

Personnel safety requirement shall conform to Requirement 1 of MIL-STD-454. Areas where radiation levels may equal or exceed 10 mw/cm^2 will be calculated and verified by measurement. This power level is the ALL-SERVICE accepted safe level for personnel.

3.2.1.7.2 Fuel Safety

Areas where radiation levels may equal or exceed 5 watts/cm^2 peak will be calculated and verified by measurement. This power level is the USAF accepted safe level for aircraft fuel (USAF Manual T.O – 31Z – 10 – 4).

3.2.1.7.3 Ordnance Safety

Provisions to protect ordnance systems shall be included in system design. Ordnance includes weapons, rockets, explosives, EED's, squibs, flares, igniters, explosive bolts, destruct devices, and RATO and JATO bottles. The design and selection of EED's and associated circuitry shall be in accordance with MIL-P-24014. EEDs with "no-fire" current/power characteristics shall be specified for XY-1A use.

3.2.1.8 EMC Analysis

3.2.1.8.1 Power System Coupled Interference Analysis

An analysis will be made to define the interference profile on each power distribution system. This will be compared with a conducted susceptibility threshold profile based on estimated coupling values. Where interference levels exceed susceptibility thresholds, an adjustment must be made to reduce emission levels and/or improve susceptibility thresholds. The analysis will include factors of dollar cost, schedule impact, and space and weight penalties so that trade-offs can be evaluated in decision making.

The computer analysis program has been developed by Wandow and used on previous systems with success. Emission and susceptibility characteristics are available for all GFE. The estimates of these characteristics for CFE will be upgraded periodically during development and testing.

3.2.1.8.2 Antenna Coupled Interference Analysis

An analysis of on-board RF equipments has been performed to define the conducted interference and susceptibility levels at the antenna terminals necessary to a compatible system. The analysis was based on the XY-1A configuration, and it considered all the parameters such as antenna gains, transmitter power outputs, path losses, aircraft shadowing, and receiver sensitivity.

Since most of the RF equipments are in existence, Wandow has compared the RF specification requirements with the XY-1A EMC Requirements. The comparison has shown certain incompatibilities for which solutions will be developed.

A program is being developed by Wandow whereby an external analysis can be performed with a digital computer. The computer analysis will be used to confirm these incompatibilities and define problem levels using updated antenna characteristics and more accurate receiver-transmitter parameters. An example of the parameters included in the program and the incompatibility equation is presented in Exhibit D.

3.2.1.9 Antenna Coupled Interference Reduction Techniques

3.2.1.9.1 Antenna Parameters and Location for Interference Reduction

Interference between communications and D-band equipment will be reduced by the selection of antenna location to take advantage of aircraft structure shadowing. In the development of antenna radiation patterns, attention will be given to lobe and null structure to take advantage of these factors in antenna decoupling. The lobe and null structure will be considered not only at the operating frequency but also at harmonic and other critical response frequencies. Antenna mounting design and orientation will be arranged to provide any additional decoupling possible by this means.

3.2.1.9.2 Frequency Domain Filtering

Antenna line filters will be used to resolve incompatibilities that cannot be reduced sufficiently by antenna design or location.

A low-pass filter will be used in the communications antenna feed line to reduce harmonic radiation that interferes with D-band equipment. The communications receiver will make use of a high-pass filter to alleviate intermodulation problems associated with the ADF receiver local oscillator radiation.

Band-pass filters will be used in the antenna feed line of the countermeasures transmitter to reduce out-of-band radiation interference with on-board systems.

3.2.1.9.3 Frequency Assignment

The frequency assignment program will be developed for compatibility among all systems during operation. System blanking will be required for certain operational conditions.

3.2.1.9.4 Time Domain Interference Solution

Interaction of equipments operating in overlapping or adjacent frequency channels may be prevented by limiting simultaneous radiation of certain equipments while still maintaining required operational capabilities. Programmed blanking based on functional priorities will be developed as an adjunct of the EMC program.

3.2.2 Subsystem Requirements

The EMC requirements established by Wandow to achieve a compatible system consist of MIL-STD-461A and MIL-STD-462 as a base line, general supplements for all equipments, and special supplements for each RF receiver and transmitter. The general supplements are based on experience and typically consist of more stringent requirements for radiated susceptibility, low-frequency induction field susceptibility, and transient radiated and conducted susceptibility. Consideration has been given to the impact of these limits on system effectiveness, cost, and weight.

The special supplements for each RF equipment have been derived from the results of the analysis (3.2.1.8). These requirements are defined in terms of conducted interference and susceptibility at antenna terminals.

3.2.2.1 Subsystem General EMI Requirements

XY-1A electrical/electronic equipment shall meet general requirements for EMI generation and susceptibility listed in Exhibit G.

3.2.2.2 Subsystem Antenna Line Conducted EMI Requirements

XY-1A radio frequency (RF) receiver and transmitter (RT) subsystems shall meet the general requirements listed in Exhibit G and special supplemental RF antenna line conducted EMI requirements listed in Exhibit H.

3.2.2.3 Specific Subsystems EMI Requirements

The applicability of general and special EMI requirements to each equipment is indicated below.

3.2.2.3.1 AN/ASN-00 Inertial Navigation System (code 1.10)
GFE – paragraph 3.2.2.1 (Code 1.10 and subsequent code numbers are from Wandow A/C Equipment List)

3.2.2.3.2 A24G-00A Attitude Heading Reference (code 1.20)
GFE – paragraph 3.2.2.1

3.2.2.3.3 AN/ARN-0 or AN/ARN-0A TACAN (code 1.30)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.5 Central Air Data Computer (code 1.50)
CFE, Airsystem Div. Marquet Corp., Larksville, Pa. – paragraph 3.2.2.1.

3.2.2.3.6 Central Interference Converter Unit (code 1.75)
CFE, Wandow – paragraph 3.2.2.1

3.2.2.3.7 AN/APN-00 (V) Radar Altimeter (code 1.90)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.8 LS-000 B/AIC Intercommunications Station (code 2.11)
GFE – paragraph 3.2.2.1

3.2.2.3.9 AN/APX-0 IFF Transponder (code 2.20)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.10 AN/APX-0A IFF Interrogator (code 2.30)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.11 Julian-00 Cryptographic System (code 2.40)
GFE – paragraph 3.2.2.1. Responsibility for test and compliance with FED-STD-222 rests with NAVAIR.

3.2.2.3.12 AN/ARC-00A UHF Communication Set (code 2.50)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.13 MX-000/U Interference Blanker (code 2.60)
CFE, seller to be determined

3.2.2.3.14 CV-000/ASW-00 Digital Data Link (code 2.71)
GFE – paragraph 3.2.21

3.2.2.3.15 RT-000/ARC-00 UHF Data Link Transmitter – Receiver (code 2.81)
CFE, Electrical Computations Co., Kingston, Pa. – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.16 SA-000/A Antenna Switch (code 2.82)
GFE – paragraph 3.2.2.1

3.2.2.3.17 R-000/ARR-00 UHF Auxiliary Receiver (code 2.110)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.18 R-000/AKQ-0 TAC TEL Receiver (code 2.131)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.19 R0-000/AKQ-0 TAC TEL Recorder (code 2.132)
GFE – paragraph 3.2.2.1

3.2.2.3.20 SA-000/AKQ-0 Antenna Switch (code 2.133)
CFE – paragraph 3.2.2.1

3.2.2.3.21 AXLS Beacon Augmentor (code 2.140)
GFE – paragraph 3.2.2.1

3.2.2.3.22 AN/APN-00 (V) Radar Beacon (code 2.150)
GFE – paragraph 3.2.2.1

3.2.2.3.23 Automatic Flight Control System (code 3.00)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.24 Approach Power Control (code 3.30)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.25 Coded Integrated Armament System (code 5.10)
CFE, Fairfield Fuller, Edwardsville, Pa. – paragraph 3.2.2.1

3.2.2.3.26 AM-000/AWW-0A Amplifier Power Supply Fuze Function (code 5.20)
CFE – paragraph 3.2.2.1

3.2.2.3.27 Gun Control Unit (code 5.40)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.28 Waveguide Switch (code 5.52)
GFE – paragraph 3.2.2.1

3.2.2.3.29 AN/AWG-0/VGX Airborne Missile Control System (code 6.00)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.30 AN/APR-00 (V) Electronic Countermeasures Receiver (code 6.20)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.31 AN/APR-0A Electronic Countermeasures Receiver (code 6.60)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.32 AN/ALQ-00 Defensive Electronic Countermeasures (code 7.30)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.33 AN/ALQ-00A Defensive Electronic Countermeasures (code 7.60)
GFE – paragraphs 3.2.2.1 and 3.2.2.2

3.2.2.3.34 AN/ALR-00 Infra-red/Optical Detection System (code 7.40)
GFE – paragraph 3.2.2.1

3.2.2.3.35 AN/ALE-00A Chaff/Flare Dispenser (code 7.50)
GFE – paragraph 3.2.2.1

3.2.2.3.36 Vertical Display Indicator Group (code 9.10)
CFE. Mahler Indicator Corp., Wilkes Barre, Pa.

3.2.2.3.37 HEPIG System (code 9.20)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.38 Integrated Drive Generator, Generator Control Unit (code 10.02, 10.03)
CFE, Grassland, Pittston, Pa. – paragraph 3.2.2.1

3.2.2.3.39 Transformer Rectifier (code 10.06)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.40 Emergency Generator (code 10.20)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.41 Ground Power Monitor (code 10.30)
CFE – paragraph 3.2.2.1

3.2.2.3.42 WCS Switching and Power Supply (code 10.46)
CFE, seller to be determined – MIL-STD-461A

3.2.2.3.43 Flasher (code 11.21)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.44 Ext/Int Multi-Channel Dimmer Control (code 11.24)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.45 Indicator Digital Data (code 2.72)
CFE, Manfred System, Plymouth, Pa. – paragraph 3.2.2.1

3.2.2.3.46 Windshield Controller (code 11.65)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.47 Anti Ice (code 11.70)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.48 Fire Detection (code 11.75)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.49 Programmer Inlet Control (code 11.85)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.50 Panels, Control (code 12.00)
CFE, Wandow and sellers to be determined – MIL-STD-461A for panels containing switches only, paragraph 3.2.2.1 for panels containing solid state circuitry.

3.2.2.3.51 Switching Units (code 12.100)
CFE, Wandow – MIL-STD-461A for units containing relays only; paragraph 3.2.2.1 for units containing solid state circuitry.

3.2.2.3.52 Angle of Attack System (code 13.10)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.53 AAU-00/A Altimeter (code 13.21)
CFE – paragraph 3.2.2.1

3.2.2.3.54 AAU-0A/A Altimeter, Cabin Pressure (code 13.22)
GFE – paragraph 3.2.2.1

3.2.2.3.55 Indicator, Counting Accelerometer (code 13.41)
GFE – paragraph 3.2.2.1

3.2.2.3.56 G Meter ABU-0A/A (code 13.44)
GFE – paragraph 3.2.2.1

3.2.2.3.57 Vertical Velocity Indicator (code 13.50)
GFE – paragraph 3.2.2.1

3.2.2.3.58 Indicator Mach/Airspeed (pilot) (code 13.61)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.59 Indicator Mach/Airspeed (MCO) (code 13.62)
GFE – paragraph 3.2.2.1

3.2.2.3.60 ID – 000/A Attitude Indicator (code 13.80)
GFE – paragraph 3.2.2.1

3.2.2.3.61 Engine Instrument Group (code 13.110)
CFE, Bell Ringling Instrument Co., Larksville, Pa. – paragraph 3.2.2.1

3.2.2.3.62 GEU-0/A Tach (code 13.115, 13.120)
GFE – paragraph 3.2.2.1

3.2.2.3.63 NO Converter (code 13.121)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.64 Hydraulic Pressure Indicator (code 13.136)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.65 Nozzle Position Set (code 13.140)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.66 Oil Pressure Set (code 13.145)
GFE – paragraph 3.2.2.1

3.2.2.3.67 ABU-00/A Clock (code 13.202)
GFE – paragraph 3.2.2.1

3.2.2.3.68 AQU-0/A Compass (code 13.204)
GFE – paragraph 3.2.2.1

3.2.2.3.69 ID-00 C/U Bearing Direction Heading Indicator (code 13.205)
GFE – paragraph 3.2.2.1

3.2.2.3.70 Oxygen Indicator (code 13.311)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.71 CRU-00A Converter (code 13.312)
GFE – paragraph 3.2.2.1

3.2.2.3.72 Fuel Quantity Measurement System (code 13.320)
CFE, Lowe Aircraft Instruments Co., Harveys Lake, Pa. – paragraph 3.2.2.1

3.2.2.3.73 Oil Quantity Detector (code 13.336)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.74 Control Surface Position Set (code 13.420)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.75 Indicator, Wheels/Flaps/Slats/Speed/Brake (code 13.45?)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.76 Indicator Set, Wing Sweep (code 13.500)
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.77 Machine Gun
GFE – paragraph 3.2.2.1

3.2.2.3.78 Ammunition Handling System
CFE, seller to be determined – paragraph 3.2.2.1

3.2.2.3.79 TF30-P-00 Engine
GFE – paragraph 3.2.2.1

3.2.2.3.80 AIM-00 Missile
GFE – paragraph 3.2.2.1

3.2.2.3.81 AIM-00M Missile
GFE – paragraph 3.2.2.1

3.2.2.3.82 AIM-00 Missile
GFE – paragraph 3.2.2.1

3.2.2.3.83 A/A 37B-0 Multiple Ejection Rack
GFE – paragraph 3.2.2.1

3.2.2.3.84 A/A 37B-0A Triple Ejection Rack
GFE – paragraph 3.2.2.1

3.2.2.3.85 ZAP Rocket Pods
GFE – paragraph 3.2.2.1

3.2.2.3.86 Phony Missile Environmental Control System
CFE, Seller to be determined – paragraph 3.2.2.1

3.2.2.3.87 Mk-00, BIGEYE Bombs (equipped with Electric Fuzing)
GFE – paragraph 3.2.2.1

3.2.2.4 Subsystem Design (CFE)
The design procedures and techniques that will be used to insure compliance of CFE to the requirements specified in 3.2.2.3 will be contained in each EMI Control Plan submitted by the seller. Upon approval, each subsystem EMI Control Plan becomes a part of this Control Plan.

3.3 Test-Verification of Design
To supplement the analysis, the seller developmental subsystem test, and the system functional compatibility tests, Wandow will perform tests as needed to verify the adequacy of EMI design of the XY-1A weapon system.

3.3.1 Subsystem Shielded / Room Tests
Selected GFE subsystems may be tested by Wandow to establish the degree of compliance to requirements specified in 3.2.2.1 and to determine antenna terminal emission and susceptibility characteristics. Such tests will be run when the system design parameters might be significantly affected by subsystem test data.

3.3.2 Antenna Model Tests
The 1/10 scale antenna model will be used in frequency ranges where practicable, to verify in-band antenna isolation deficiencies. Such tests are expected to be useful where shadowing and reflections from complex airframe geometry can not easily be factored into theoretical calculations.

3.3.3 STSL System Test
The System Test Simulation Laboratory (STSL) will be used for functional compatibility tests on system components. The STSL integration frame will simulate aircraft configuration in respect to major EMI design parameters, except external antenna coupling. Antenna coupling will be simulated by hard-

line links to RF equipment with attenuators and directional couplers. The effects on system performance of isolation deficiencies, filter rejection capabilities, blanking effectiveness, coupling in braided harness, equipment bonding methods, and equipment susceptibility and emissions characteristics can be evaluated. This will include an evaluation of the total effect on system performance when a particular equipment does not meet the limits of MIL-STD-461A. Design modifications that could have a significant impact on aircraft performance can be tested in STSL before the release of production drawings, hardware alteration, or flight test. The test procedures generated for STSL system test will be used in formulating portions of the aircraft functional system compatibility test.

3.3.4 STSL Problem Simulation

Problems encountered during aircraft flight test or system functional compatibility test can be simulated with STSL. Engineering investigation of such problems can be performed without the restrictions imposed by weather, airframe availability, aircraft down time, flight conditions, or airframe and equipment configuration. Extremes of equipment operation, both realistic and unrealistic, with or without breakout boxes, are possible with STSL to determine interference mechanisms.

4.0 Quality Assurance Provisions

4.1 Resources for Test and Developmental Investigations

The following facilities are available for subsystem developmental and qualification tests, system developmental tests, and aircraft system tests:

Wandow Larksville Plant Electronics Laboratory, several shielded rooms, one antenna anechoic test chamber

Wandow Kingston Test Site, one aircraft anechoic test chamber (see Exhibit H) one aircraft shielded hangar, two shielded rooms, one airstrip suitable for jet aircraft flights and for ground engine run tests

Navy Point Mugu Test Site, one system test integration laboratory, one airstrip

The types of test equipment to be used at Wandow, Plymouth, Pa., and Point Mugu, Calif., facilities are listed in Exhibit I.

4.2 Tests

The following tests will be performed to demonstrate compliance to MIL-E-6051 and MIL-B-5087, according to MIL-D-8706 and MIL-D-8708.

4.2.2 Specification Compliance Test

A specification compliance test will be performed on XY-1A aircraft number 14. This test will verify the effectiveness of design modifications that have been engineered to correct deficiencies noted in the functional compatibility test.

4.2.3 Safety of Flight Test

An abbreviated functional compatibility test will be performed on each research and development aircraft, before first flight, to insure freedom from electromagnetic interactions that could endanger safety of flight. This test will be conducted on the runway apron. Other safety of flight tests will be run when significant equipment additions are made to the aircraft.

4.2.4 Radiation Hazards Test

A power density measurement vs. distance and orientation (including cockpit) will be made on XY-1A aircraft number 6 with an operational AWG-0 radar. This test will be performed on the runway apron.

4.2.5 Bonding Test(s)

Electrical bonding measurements will be made on aircraft structural assemblies and electrical/electronic mounting provisions. Emphasis shall be given to measurement of fuel system components and protrusions vulnerable to lightning.

4.2.6 Lightning Tests

Wandow will perform simulated lightning strike tests on sample boron composite structure panels to substantiate the suitability of protection methods. The seller of the aircraft nose radome will perform simulated lightning strike tests to verify immunity of this structure to damage. The subcontractor of the lightning protection study will conduct simulated lightning discharge tests on a scale model XY-1A to determine vulnerable locations on the aircraft.

4.2.7 MIL-STD-449 Test

Measurements of receiver-transmitter antenna line spectrum characteristics will be made for the ARC-000, the only CFE RF unit.

4.3 Data Requirements

To provide EMI information, testing method descriptions, and test results, the following data will be submitted to NAVAIR (53356) and Naval Air Test Center (WST-323).

4.3.1 CFE Subsystem EMI Control Plan

Each CFE subsystem to be designed and tested to the requirements of 3.2.2.1 will have an applicable EMI Control Plan submitted by the seller in accordance with specification SPECSE016.

4.3.2 CFE Subsystem EMI Qualification Test Procedure

Each CFE subsystem requiring EMI qualification testing will have an applicable EMI Qualification Test Procedure submitted by the seller. This procedure will be a detailed test description written at the engineering technician level. The procedure shall contain test equipment to be used, calibration of test equipment, test set-up description, methods of loading and triggering, test sample operation, pass-fail criteria, and sample data sheets.

4.3.3 CFE Subsystem EMI Qualification Test Report

Each CFE subsystem requiring qualification testing will have an applicable EMI Qualification Test Report submitted by the seller. This report will contain all data recorded during test as well as summaries of test results and a statement indicating whether the pass-fail criteria of the test procedure were met.

4.3.4 Control Plan Amendment

Amendments to this Control Plan will be generated when there have been significant changes related to EMI management, technical requirements, testing, and data requirements.

4.3.5 Analysis Reports

A report of the computer or manually generated analysis for predicted problem areas including antenna-coupled transmitter receivers will be prepared. It will show predicted incompatibilities, problem levels, associated frequencies, and proposed methods of solution.

4.3.6 Problem Reports

Problem reports will be generated when significant EMI problems, theoretical or empirical, not described in other submitted test reports or analyses, are evident. Solutions to problems indicated by the analysis will be included.

4.3.7 Bonding Report

A bonding report will be prepared containing measured bonding resistance data taken from prototype and production aircraft. It will include a statement of compliance or of specification violation and correction.

4.3.8 Lightning Report

A lightning report will be submitted that contains: boron composite structure simulated lightning strike test results; seller-submitted radome simulated lightning strike test results. subcontractor-submitted scale model electrical discharge test results, recommendations, and an analysis.

4.3.9 MIL-E-6051, Functional Compatibility Test Plan

A System Functional Compatibility Test procedure in accordance with MIL-E-6051 and with Wandow exceptions of Exhibit C will be generated. Test equipment, test equipment operation, calibration, test sample operating modes, control settings, frequencies, mointoring points, pass-fail criteria–including safety margins when applicable, and a test site description will be included. Subsystem and SITS test results will be used to the maximum to insure inclusion of worst case conditions Applicable portions of this procedure will be used for the specification compliance test.

4.3.10 Functional Compatibility and Specification Compliance Test Reports

Test reports on the MIL-E-6051 functional compatibility and specification compliance test will be made. Data recorded during test, test results, any modification of test plan procedures, and statement of compliance or of specification deviation will be included.

4.3.11 MIL-STD-449 Data

Receiver-transmitter spectrum data will be submitted on the ARC-000 in accordance with contract data requirements.

5.0 Preparation for Delivery

This section is not applicable to this EMI control plan.

6.0 Notes

6.1 Definitions

Definitions applicable to this control plan are per MIL-STD-463 and MIL-E-6051 as modified by Exhibit C.

EXHIBIT A

OF

APPENDIX A

TO

NAVAIR EMC EDUCATIONAL MANUAL

WANDOW SPECIFICATIONS FOR

XY-1A WEAPON SYSTEM

EXHIBIT A

WANDOW SPECIFICATIONS FOR XY-1A WEAPON SYSTEM

Electromagnetic Interference Control Requirements for Sellers, General Specification for XY-1A Weapon System	SPECSE015
Electromagnetic Compatibility Wiring Separation and Shield Grounding, Requirements for XY-1A Weapon System	SPECEW200
Electrical Bonding Requirements, General Specification for XY-1A Weapon System	SPECER300

WANDOW AIRCRAFT ENGINEERING CORPORATION

PLYMOUTH, PA.

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Specification No.	SPECSE016
Release Date	8 November 19XX

ELECTROMAGNETIC INTERFERENCE CONTROL REQUIREMENTS
FOR SELLERS
GENERAL SPECIFICATION FOR
XY-1A WEAPON SYSTEM

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NAVPLANTREPO, Springfield Engineering Date

ELECTROMAGNETIC INTERFERENCE CONTROL REQUIREMENTS

FOR SELLERS

GENERAL SPECIFICATION FOR

VFX WEAPON SYSTEM

1.0 SCOPE

1.1 General

This specification establishes the general requirements for an organized, comprehensive Electromagnetic Interference (EMI) Control Program to be conducted by the seller. The requirements specified herein are necessary to ensure the attainment of the EMI requirements stated in the applicable equipment specifications.

2.0 APPLICABLE DOCUMENTS

2.1 Selection of Specifications and Standards

Applicable publications shall be those contained in the LIST OF SPECIFICATIONS AND STANDARDS (Book Form) APPROVED BY THE NAVAL AIR SYSTEMS COMMAND, NAVAIR 00-25-544, dated October 1966 and the LIST OF STANDARD DRAWINGS USED BY THE NAVAL AIR SYSTEMS COMMAND, NAVAIR 00-25-543, dated March 1967. Other applicable publications not contained in the above lists shall be the issue in effect on 1 May 1968, except as noted herein. All standards and specifications other than those established for use by the Naval Air Systems Command must be approved by the procuring activity prior to use as a part of this specification.

2.1.1 General

The following documents of the exact issue shown form a part of this specification to the extent specified herein:

PUBLICATIONS

NAVAIR 00-25-543 March 1967	List of Standard Drawings Used by the Naval Air Systems Command
NAVAIR 00-25-544 October 1966	List of Specifications and Standards (Book Form) Approved by the Naval Air Systems Command

2.1.2 Availability of Documents

(a) When requesting military specifications, standards, drawings, and publications refer to both title and number. Copies of applicable specifications required in connection with specific procurement functions may be obtained upon application to the Commanding Officer, Naval Supply Depot, Code 105, 5801 Tabor Avenue, Philadelphia, Pennsylvania, 19120.

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(b) Copies of this specification or applicable subsidiary Wandow specifications may be obtained from Wandow Aircraft Engineering Corporation, New York, New York, Attention: XY-1A Subcontractor Manager.

3.0 REQUIREMENTS

3.1 General

The seller shall develop and initiate an EMI control program to assure his adequate control over all operations, design, development, testing, and production phases of the contract. This EMI program shall recognize the concept of interference-free design; i.e., that absence of interference is limited by the design, and that effort must be concentrated early in the design phase. Emphasis on interference-free design results in a design suitable for use in the intended operational environment.

3.1.1 EMI Control Program

The seller shall submit an EMI control program plan to the procuring activity in accordance with the applicable Seller Requirements Document. As a minimum, the seller's EMI Control Program must include the following factors in the equipment design:

(a) EMI control must be a major factor in planning, management, and engineering.

(b) Improvement of interference-free design is best achieved in the early phases of the development and test programs.

(c) Maintaining control of interference requires planned production, quality control, and testing programs.

(d) The achieved absence of interference is a basic factor that determines the electromagnetic compatibility of the operational article. Necessary improvements in the basic design shall be made to achieve the required electromagnetic compatibility in operational use.

(e) Prediction and measurement of interference at pre-planned steps of the design, development, and test phases to provide a means of evaluating progress.

(f) The collection, analysis, and feedback of information to the proper activity with appropriate follow-up are fundamental to the accomplishment of a design.

3.2 Management Controls

It is not the intent of this specification to require any particular form of organization, but rather to require evidence that the procedures and controls are adequate to insure that the minimum functions are performed to achieve all requirements. Management tasks shall include the identification of the design points inherent in the design phase and the scheduling of the corresponding EMI control monitoring points. The design points shall refer to, but not be limited to, the following design tasks:

(a) Logic design

(b) Design of the basic building block circuits

(c) Logic mechanization

(d) Breadboard

(e) Packaging

(f) Chassis and case design

(g) Design of wiring harness

(h) Structural design

3.2.1 Controls Tasks

For each monitoring point on each separate item of equipment or component, the following EMI control tasks shall be performed by the seller:

(a) Review of all applicable analyses

(b) Preparation of proposed list of personnel attending review

(c) Review of electrical and mechanical design parameters

(d) Preparation of design reports, drawings, and other documentation

3.3 EMI Control Group

The seller shall establish an EMI Control Group consisting of personnel experienced in all applicable phases of EMI control. Steps shall be taken to ensure that these personnel are well informed and knowledgeable of newly developed EMI techniques and procedures required to achieve optimum EMI control and accomplish the EMI tasks. These steps include:

(a) Adequate training programs

(b) Attendance at EMI symposiums

(c) Possession of the latest available EMI literature

3.4 Document Review

All sketches and preliminary drawings affecting the EMI of the equipment shall be subject to review by the seller's EMI control group before their release for the preparation of final production drawings. Final drawings and specifications, and subsequent revisions, shall also be reviewed before release for manufacturing purposes. All such drawings and specifications shall be made available to the procuring activity for review.

3.5 Program Evaluation

The program evaluation shall ensure that the EMI control program established in accordance with this specification shall continue to remain adequate as it progresses and that all work affecting the EMI of the product is being performed in accordance with the EMI Control Plan. All information, such as interference prediction, EMI design reviews, development, and qualification and acceptance test data shall be used to measure equipment compatibility at each monitoring point.

3.6 Seller's EMI Subcontractor Program

The seller is responsible for the following:

(a) Ensuring that the EMI levels achieved by his subcontractors' products are consistent with the overall equipment requirements.

(b) Determining the applicable portions of this specification to be included in purchase orders to his subcontractors.

(c) Imposing upon his suppliers adequate specifications, acceptance criteria, and contractual requirements for interference control of their products.

(d) Maintaining adequate channels of communications and surveillance with all subcontractors.

3.7 EMI Control in the Design Phase

This phase of control shall ensure that the inherent interference-generating and susceptibility characteristics of the basic design are compatible with the requirements of the applicable equipment specification. Attainment of the optimum control requires the establishment of a working relationship between EMI engineering and detail design engineering. During the design phase, the following procedures shall be established:

(a) Design engineers shall be provided with all pertinent information suitably organized to assist them in making decisions that will result in optimum EMI control. Such information shall include EMI prediction analyses based on equipment signal frequencies and amplitudes.

(b) The analysis of (a) shall be conducted concurrently with the design.

(c) The seller's report system shall be in sufficient detail to enable the procuring activity to monitor the design progress and evaluate the equipment compatibility with overall system requirements.

3.8 EMI Analysis

3.8.1 Predictive Analysis

A predictive analysis shall be conducted as follows:

(a) During the design phase to ensure optimum selection of circuits and application of component parts

(b) In its most critical use, when circuits are developed as building blocks for equipment

3.8.1.1 Predictive Analysis Considerations

The predictive analysis considerations shall consider all circuits and all modes of operation, and, as a minimum, shall indicate the following data:

(a) Interference-generating capabilities (conducted and radiated)

(b) Interference susceptibility levels (conducted and radiated)

(c) Expected mode(s) of excessive interference or susceptibility

3.8.1.2 Predictive Analysis Application

The seller shall submit to the procuring activity a predictive analysis application report in accordance with the applicable Seller Requirements Document. The data obtained in 3.8.1.1 can be applied in the design for interference prediction with regard to the EMI requirements of the applicable equipment specification, as well as to ensure circuit compatibility within the equipment. If, in the opinion of the seller, the procedure would lead to pessimistic interference predictions, he may include the analysis of these circuits under less critical electrical stresses, recommend the necessary course of action, and submit the application for the procuring activity's approval.

3.8.2 Configuration Analysis

The seller shall submit a configuration analysis to the procuring activity in accordance with the applicable Seller Requirements Document. A configuration analysis shall be conducted to assist engineers in making optimum design changes before a design is frozen. To aid in making such decisions, this analysis shall compare alternate configurations using concepts, logic designs, functional arrangements, or any other techniques affecting the electromagnetic interference control of this equipment. This analysis shall be performed in conjunction with other cognizant design groups.

3.8.3 EMI Failure Effect Analysis

The seller shall submit an EMI failure effect analysis to the procuring activity in accordance with the applicable Seller Requirements Document. An analysis of all probable interference requirements failures and their effects on the capability of the system shall be conducted during the design phase. This failure-effect analysis shall be coordinated with the predictive analysis, and the results reflected in a design that is considerably interference free in its earliest phase. The results of this analysis shall also serve as basic trouble-shooting data, useful in the EMI test plan.

3.8.4 EMI Failure Analysis

The seller shall submit an EMI Failure Analysis to the procuring activity in accordance with the applicable Seller Requirements Document. All EMI failures shall be subject to analysis. This analysis shall include provisions for failure review, diagnostic testing, and corrective action to eliminate or reduce the interference or susceptibility to an acceptable level. This requirement does not reduce overall failure analysis requirements.

3.9 Design Review

Design reviews shall be planned, scheduled, and conducted to ensure the following:

(a) That the proposed design satisfies or exceeds all the EMI requirements of the applicable equipment specification or that a practical alternative is proposed for procuring activity review and approval

(b) That the design represents an optimum solution to the EMI problems under investigation

(c) That all requirements of the applicable equipment specification and this specification are met concerning EMI

3.9.1 Design Data Review

The design data review shall include the following:

(a) A detailed examination of all applicable documents, reports, drawings, and specifications

(b) Provisions for a review by the procuring activity of all significant design decisions before they are finalized

3.9.2 Design Review Schedule Submittal

The procuring activity shall be notified of all seller design reviews including those to be conducted at suppliers' facilities. Notification of the design review schedule shall precede the review data by ten working days. The procuring activity may request supplementary design reviews as necessary. Sufficient notice of these reviews will be given to the seller.

3.9.3 Design Review Material

All pertinent analysis and documentation shall be submitted in a package to each member of the review board and to the procuring activity when they are notified of the review.

3.9.4 Review Board Representation

The review board shall consist of representatives of all engineering groups that have a bearing on the design, including engineers skilled in EMI analysis, to identify design weaknesses and to recommend specific changes to meet requirements. The EMI engineering members of the review board shall follow up to assure that the EMI revisions agreed upon are made.

3.8.4 EMI Failure Analysis

The seller shall submit an EMI Failure Analysis to the procuring activity in accordance with the applicable Seller Requirements Document. All EMI failures shall be subject to analysis. This analysis shall include provisions for failure review, diagnostic testing, and corrective action to eliminate or reduce the interference or susceptibility to an acceptable level. This requirement does not reduce overall failure analysis requirements.

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The procuring activity shall be notified of all seller design reviews including those to be conducted at suppliers' facilities. Notification of the design review schedule shall precede the review data by ten working days. The procuring activity may request supplementary design reviews as necessary. Sufficient notice of these reviews will be given to the seller.

3.9.3 Design Review Material

All pertinent analysis and documentation shall be submitted in a package to each member of the review board and to the procuring activity when they are notified of the review.

3.9.4 Review Board Representation

The review board shall consist of representatives of all engineering groups that have a bearing on the design, including engineers skilled in EMI analysis, to identify design weaknesses and to recommend specific changes to meet requirements. The EMI engineering members of the review board shall follow up to assure that the EMI revisions agreed upon are made.

3.9.5 Design Changes After Review

Design changes made after a review shall be subjected to review and verification as described in 3.9. This may necessitate design reviews at periods intermediate to the scheduled monitoring points, which will provide for a continuous review program and will allow for the earliest possible detection of any problems.

3.10 Repair and Modification

The seller shall maintain interference control during repair and modification operations on all equipments, including those items returned subsequent to initial receipt by the procuring activity. The EMI control procedures shall be the same as those established during the manufacturing phase.

3.11 Surveillance of Test Program

Close EMI surveillance shall be maintained over the EMI portions of the equipment development, preproduction qualification, and acceptance testing programs. This will ensure that the EMI requirements of the applicable equipment specification are met.

3.11.1 EMI Engineering Representation

The cognizant procuring activity representative shall be invited to witness or monitor all tests for which EMI test plans are required.

3.12 Data

Only that data listed in the schedule of the Seller Requirements Document must be submitted.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General

Equipment covered by this specification shall be subject to developmental tests and a preproduction qualification test to ensure compliance with the requirements of the applicable equipment specification.

4.2 Developmental Test Requirements

4.2.1 Test Plan

Before the performance of a test, a developmental test plan shall be submitted to the procuring activity as required by the applicable Seller Requirements Document.

4.2.2 EMI Developmental Tests

These tests shall be performed on breadboard, WRA, and system levels during various stages of design and before formal EMI Preproduction Qualification Testing. These tests shall be performed to obtain a high level of confidence in the final EMI design before Preporduction Qualification Test.

4.2.3 Test Report

Upon completion of each EMI Developmental Test, a report shall be submitted to the procuring activity in accordance with the applicable Seller Requirements Document.

4.3 Preproduction Qualification Test Requirements

4.3.1 Test Plan

Before the performance of a test, a preproduction qualification test plan shall be submitted to the procuring activity for approval as required by the applicable Seller Requirements Document.

4.3.2 Test Facilities

Tests shall be performed at the seller's facilities where practicable. A seller not having adequate facilities shall engage the services of a satisfactory commercial testing laboratory. All test facilities shall be described within the test plan and shall be subject to the approval of the procuring activity.

4.3.3 Test Specimen

The test specimen(s) for the EMI preproduction qualification test shall be selected by the procuring activity as being representative of the production equipment(s) to be supplied as contract items.

4.3.4 EMI Qualification Tests

These tests shall be performed on the test specimen(s) in accordance with the requirements of the applicable equipment specification, the control plan, and this specification. These tests shall be so performed that each mode of operation is used during each test performed, as it would be during typical operation.

4.3.5 EMI Test Failures

All failures shall be reported and analyzed in accordance with the requirements of 3.8.4. An EMI failure shall be as defined in 6.1.3. In case of doubt regarding the existence of a failure, the decision of the procuring activity representative shall be final.

4.3.6 Test Witness

The preproduction qualification test shall be witnessed or monitored by an authorized representative of the procuring activity.

4.3.7 Rejection and Retest

Equipment that fails to pass the EMI qualification test, in accordance with the requirements of 4.3.4 herein, shall be reworked and resubmitted for acceptance. Full particulars concerning the rejection and the action taken to correct the defect(s) found in the original test will be furnished to the procuring activity. Information furnished shall be in accordance with the Seller Requirements Document.

4.3.8 Test Report

Upon completion of the EMI tests and subsequent retests, a report, signed and certified by an authorized representative of the seller or an approved commercial testing laboratory, shall be submitted to the procuring activity for approval in accordance with the applicable Seller Requirements Document.

5.0 PREPARATION FOR DELIVERY.

Not applicable

6.0 NOTES

6.1 Definitions

6.1.1 Component

A component is defined as an article that is normally a combination of parts, subassemblies or assemblies and is a self-contained element of a complete operating equipment that performs a function necessary to the operation of that equipment.

6.1.2 Equipment

An equipment consists of one or more components capable of performing specific functions.

6.1.3 EMI Failure

An emissions measurement that does not meet the applicable EMI specification requirements after the application of the proper correction factors, constitutes an EMI failure. Each undesired response shall also be considered as an EMI susceptibility failure if such undesired response is caused by interference, either external or internal to the equipment under consideration. Any deviation from a specified output, increase or decrease, shall be considered as an undesirable response.

6.1.4 Procuring Activity

Where the words "procuring activity" are used herein, they refer to the Wandow Aircraft Engineering Corporation.

6.1.5 Seller

Where the word "seller" is used herein, it refers to the subcontractor who has the responsibility for the design, construction, and test of the equipment covered by the applicable equipment specification.

6.2 Precedence of Documents

When the requirements of the contract, equipment specification, this specification or subsidiary specifications are in conflict, the following precedence shall apply:

(a) Contract – The contract (or purchase order) shall have precedence over any specification.

(b) Equipment Specification – The applicable equipment specification shall have precedence over this specification.

(c) This Specification – This specification shall have precedence over all referenced subsidiary specifications. Any deviation from this specification or from subsidiary specifications, shall be specifically approved in writing by the procuring activity.

(d) Referenced Specification – Any referenced specification shall have precedence over all subsidiary specifications referenced therein. All referenced specifications shall apply to the extent specified herein.

WANDOW AIRCRAFT ENGINEERING CORPORATION

PLYMOUTH, PA.

Specification No. SPECEW200

Release Date 15 July 19XX

ELECTROMAGNETIC COMPATIBILITY WIRING SEPARATION, AND SHIELD GROUNDING, REQUIREMENTS FOR XY-1A WEAPON SYSTEM

B. Greene Specifications Engr	J. Dough Proj Engr
F. Smith Cognizant EMC Engr	M. Blanc Deputy Engr Mgr
R. Brown EMC Dept. Head	W. Schwartz Support Mgr
	A. Jones Engrg Mgr

1.0 SCOPE

1.1 Scope

This specification establishes the procedures for wiring separation and shield grounding necessary to effect systems electromagnetic compatibility of the XY-1A weapon system.

2.0 APPLICABLE DOCUMENTS

2.1 Selection of Specifications and Standards

Applicable publications are those contained in the LIST OF SPECIFICATIONS AND STANDARDS, APPROVED BY THE NAVAL AIR SYSTEMS COMMAND, NAVAIR 00-25-544, dated October 1966, other specifications in the materials and processing areas shall be those contained in the LIST OF SPECIFICATIONS AND STANDARDS (Book Form) APPROVED BY THE NAVAL AIR SYSTEM COMMAND NAVAIR 00-25-544 dated May 1968; and the LIST OF STANDARD DRAWINGS USED BY THE NAVAL AIR SYSTEMS COMMAND, NAVAIR 00-25-543, dated March 1967. Other applicable publications not contained in the above lists shall be the issue in effect on 1 May 1968, except as noted herein. All standards and specifications other than those established for use by the Naval Air Systems Command must be approved by the procuring activity before use as a part of this specification.

2.1.1 General

The following documents of the exact issue shown form a part of this specification to the extent specified herein:

SPECIFICATIONS

Military

MIL-W-5088C	Wiring, Aircraft, Installation of

OTHER PUBLICATIONS

NAVAIR 00-25-543 dated March 1967	List of Standard Drawings
NAVAIR 00-25-544 dated May 1968	List of Specifications and Standards
CAP-68-80D1 dated January 1969	Cable Harness Assembly; Design and Fabrication of

2.1.2 Availability of Documents

(a) When requesting military specifications, standards, drawings, and publications, refer both to title and number. Copies of applicable specifications required by contractors in connection with specific procurement functions may be obtained upon application to the Commanding Officer, Naval Supply Depot, Code 105, 5801 Tabor Avenue, Philadelphia, Pennsylvania, 19120.

(b) Copies of this specification of applicable Wandow documents may be obtained from Wandow Aircraft Engineering Corporation, New York, New York, Attention: XY-1A Subcontracts Manager.

3.0 REQUIREMENTS

3.1 General

The wiring of electrical and electronic equipments aboard the XY-1A airplane shall conform to the requirements specified herein and to those specified in Specification MIL-W-5088. This requirement applies to all electrical/electronic equipments installed in the XY-1A airplane. Compliance to the wiring separation and shield grounding requirements are necessary to preclude coupling of interference from one circuit to another. Deviations from the wiring requirements specified herein shall be permitted if approved by the XY-1A EMC Group.

3.2 Wire and Cable Coding

EMC coding shall appear on all wiring diagram layouts and harness charts to indicate the required wiring separations. The EMC code shall be in accordance with the instructions defined below.

3.2.1 Coding Instructions

The following instructions for EMC coding shall apply.

3.2.1.1 EMC Code Group, 1st Digit

The first digit of the EMC Code Group designates the subsystem group in accordance with Specification MIL-W-5088 as delineated in Table I of this specification. The separations to be provided between different subsystems shall be as specified in 3.3.1.1.1.

3.2.1.2 EMC Code Group, 2nd Digit

The second digit of the EMC Group Code designates the individual equipment in accordance with Table I. The separations to be provided between equipments of the same subsystem shall be as specified in 3.3.1.1.2.

3.2.1.3 EMC Code Group, 3rd Digit

The third digit of the EMC Code Group designates the connector number for those signals emanating from the individual equipment. Connector number 10 shall be designated by "0." Where more than ten connectors are used on one equipment, letters shall be used for the eleventh and subsequent number of connectors. The separations to be provided between connector wire bundles shall be as specified in 3.3.1.1.3.

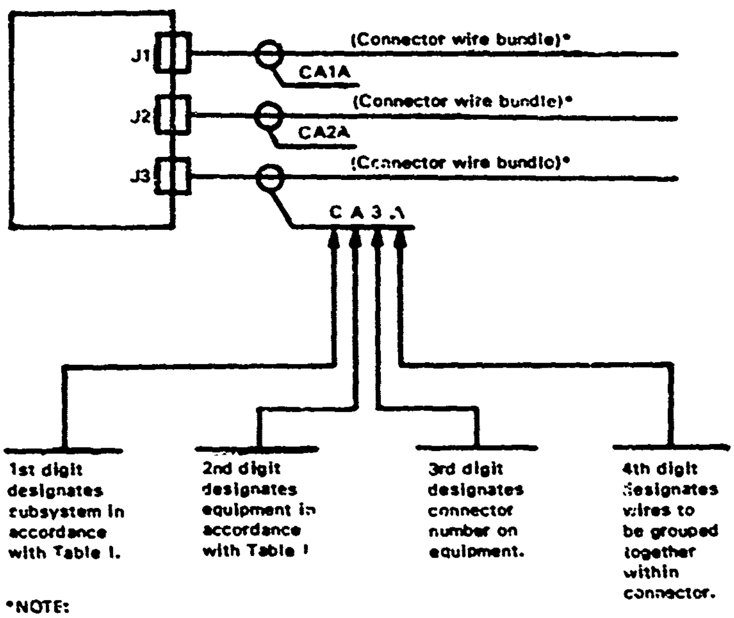
3.2.1.4 EMC Code Group, 4th Digit

The fourth digit of the EMC Code Group designates the grouping of wires whose signals emanate from the same connector on an equipment. Normally, all wires whose signals are marked with the letter "A" will be grouped together. Those wires shall be grouped together to comprise the connector wire bundle. However, when coaxial wires exist within a connector, they will receive the letter "C" and be grouped together to comprise a coaxial wire bundle. If wires within a connector require special separation, they will receive either the letters "S," "T," "U," "V," or "W" and be grouped to comprise special wire bundles. The separation to be provided between connector wire bundles and the coax wire bundles and/or the special wire bundles shall be as specified in 3.3.1.1.4 and 3.3.1.1.5.

3.2.1.5 Left and Right Generator BUSS Classification

Distinction shall be made between left hand generator and right hand generator usage. Electrical/electronic equipment that uses primary power from the right hand generator shall be classified by underlining the code.

3.2.1.6 Example of EMC Group Code



*NOTE:

Connector wire bundles shown consist only of those wires whose signals emanate from the connector.

TABLE I

SUBSYSTEM AND EQUIPMENT EMC CODES

Subsystem	EMC Code 1st Digit	Equipment	EMC Code 2nd Digit
Armament	A	Armament Control (CIACS)	A
		Amplifier, Power Supply	B
		Control Unit, Gun	C
Control Surface	C	Auto Flight Control System	A
		Approach Power Control	B
		Central Air Data Computer	C
Instruments	D	Oxygen System	A
		Wing Sweep Indicator	B
		Control Surface Position	C
		Hydraulic Pressure Indicator	D
		Cabin Pressure Indicator	E
		Wheels and Flaps Indicator	F
		Brake Pressure Indicator	G
		Probe Heaters	H
Engine Instruments	E	Integrated Engine Indicators	A
		N1 Tach	B
		Fuel Flow Transmitter	C
		Nozzle Position	D
		Oil Pressure	E
		Fuel Quantity	F
		Total Temperature System	G
		Oil Pressure Indicator	H
		Oil Quantity Indicator	J
		Engine Pressure Ratio	K
Flight Instruments	F	Angle of Attack System	A
		Altimeters (Servo Pneumatic)	B
		Accelerometer	C
		Verticle Velocity Indicator	D

TABLE I (Continued)

Subsystem	EMC Code 1st Digit	Equipment	EMC Code 2nd Digit
		Airspeed System	E
		Pilot Static Probes	F
		Standby Attitude Indicator	G
		Bearing Distance Heading Indicator	H
		Standby Compass	J
		Attitude Heading Reference	K
		Clock	L
		Counting Accelerometer	M
		Compensator	N
		Gyroscope	P
		Controller	R
Heating, Ventilating, and De-Icing	H	Anti-Ice	A
		Anti-Skid	B
		De-Fogging	C
		Environmental Control	D
		Missile Cooling	E
		Electronic Cooling	F
		Liquid Cooling	G
		Engine Oil Cooling	H
		Hydraulic Oil Cooling	K
Ignition	J	Engine Ignition and Start	A
Engine Control	K	Air Inlet Control	A
		Mach Lever Actuator	B
Lighting	L	Exterior Lighting/Electro-luminescent (AC)	A
		Exterior Lighting/ Incandescent (AC)	B
		Interior Lighting/Electro-luminescent (AC)	C
		Interior Lighting/ Incandescent (AC)	D
		Hi-Intensity Floods	E

TABLE I (Continued)

Subsystem	EMC Code 1st Digit	Equipment	EMC Code 2nd Digit
Miscellaneous Electric	M	Canopy Control	A
		Nose Wheel Steering	B
		Launch Bar	C
		Arresting Hook	D
		Nose Radome Fold	E
		Hydraulic Valve Control	F
		Seats	G
		Landing Gear Control	H
		Landing Gear, Position	J
		Master Test Panel (Pilot)	K
		Master Test Panel (MCO)	L
		System Power/Ground Test	M
DC Power	P	DC Power System	A
Radio (Navigation and Communication)	R	Tacan-ARN-00	A
		UHF-ADF-ARA-00	B
		Intercommunication-LS-000	C
		IFF Transponder-APX-0	D
		IFF Interrogator-APX-0A	E
		Cryptographic System-KY-00	F
		UHF Comm-ARC-00A	G
		Interference Blanker-MX-000	H
		UHF Data Link-ARC-00	J
		UHF Aux Receiver-ARR-00	K
		IMU (Inertial Measurement Unit)	L
		CICU (Central Interface Converter Unit)	M
Radar	S	Radar Altimeter-APN-00	A
		Radar Beacon-APN-000	B
Special	T	Weapons Control-AIM-00	A

TABLE (Continued)

Electronics		Missile	
		Weapons Control Missile Aux	B
		Vertical Display Ind Group	C
		Pigeon Missile	D
		TV Sighting Subsystem	E
		RHAWS	F
		DECM	G
		IR Optical Detection	H
		Chaff/Flare Dispenser	J
		Tactical Telemetry	K
		ACLS Beacon Augmentor	L
		Inertial Navigation	M
Special Electronics		Digital Data-ASW-00	N
		Horizontal Situation Display	O
		AWG-0 Computer	P
		AWG-0 Power Supplies	R
		AWG-0 Radar	S
		AWG-0 Missile Auxiliary	T
		AWG-0 Infrared	U
		AWG-0 Recorder	V
		AWG-0 Controls and Displays	W
Warning and Emergency	W	Fire Detection System	A
AC Power	X	AC Generator (Right)	A
		AC Generator (Left)	B
		AC Power System Control	C
		Emergency Generator	D
		External Power	E

NOTE: Additional equipments shall be assigned accordingly by EMC Group.

3.3 **Wiring Design**

The wiring requirements specified on all wiring diagram layout and harness charts for fabrication and installation in XY-1A airplane must conform to the wiring bundling and separation procedures defined below.

3.3.1 **Wire Bundling and Separation**

The wire separation objectives for the XY-1A wiring shall be to first separate individual connector wire bundles; then separate electrical/electronic equipment wire bundles; then separate subsystem wire bundles.

3.3.1.1 **Basic Bundling and Separation**

All subsystems are defined herein, their equipments and their wiring shall be separated according to the following techniques and compromise procedures.

3.3.1.1.1 **Subsystem Wiring Separation**

All signals emanating from each subsystem shall be separated from all other subsystem wiring by a minimum of two inches (see Figure 1). The subsystem shall be designated by the first digit of the EMC code group, as specified in 3.2.1.1.

3.3.1.1.2 **Equipment Wiring Separation**

All signals emanating from an individual equipment shall be separated from all other equipment wiring within the same subsystem by a minimum of one inch (see Figure 1). The equipment shall be designated by the second digit of the EMC code group, as specified in 3.2.1.2.

3.3.1.1.3 **Connector Wire Bundle Separation**

All signals emanating from a connector on an equipment within a subsystem shall be bundled together and separated from all other connector wire bundles whose signals emanate from that same equipment by a minimum of one-half inch (see Figure 1). The connector wire bundle shall be designated by the third and fourth digit of the EMC code group as specified in 3.2.1.3 and 3.2.1.4.

3.3.1.1.4 **Coaxial Wiring Separation**

All coaxial wiring whose signals emanate from a connector shall be separated from that connector wire bundle and all other connector wire bundles by a minimum of one inch (see Figure 1). The coaxial wiring shall be designated by the fourth digit of the EMC code group, as specified in 3.2.1.4.

3.3.1.1.5 **Special Wire Separation**

Wires whose signals emanate from a connector and which require special separation from other wires within that same connector shall be separated from that connector wire bundle and all other connector wire bundles by a minimum of one inch (see Figure 1). The special wiring shall be designated by the fourth digit of the EMC code group, as specified in 3.2.1.4.

3.3.1.2 Permissible Compromises

Implementation of the permissible compromises stated below shall be recorded and filed for reference. These compromises are not applicable to the AWG-0 system wiring. Any AWG-0 subsystem wiring compromise required shall be brought to the attention of the XY-1A EMC Group, which will then indicate the compromise permissible for AWG-0 subsystem wiring.

3.3.1.2.1 First Compromise

When the specified connector wire bundle separation can not be provided per 3.3.1.1.3, the wiring containing signals emanating from each individual equipment within this subsystem shall be combined into two bundles, one bundle containing both the coaxial cables and special wire bundles, the second bundle containing all other wires, and separated by a minimum of one inch (see Figure 2). This bundling compromise is made by combining the wire bundles that have an identical first and second digit of the EMC code group and a fourth digit of the letter "A" to comprise one bundle; and combining the wire bundles that have an identical first and second digit of the EMC code and a fourth digit of either "C," "S." "T," "U," "V," or "W" to compose the other wire bundle.

3.3.1.2.2 Second Compromise

If an additional compromise must be made beyond that performed per 3.3.1.2.1, combine the two bundles whose signals emanate from each individual equipment into one bundle, and separated from all other equipment wiring by a minimum of one inch (see Figure 2). This bundling compromise is made by combining the wire bundles that have identical first and second digits of the EMC code group.

3.3.1.2.3 Third Compromise

If an additional compromise must be made beyond that performed per 3.3.1.2.2, combine the bundles whose signals emanate from each subsystem group of equipment into one bundle, separated from all other subsystem wiring by a minimum of two inches. However, this subsystem group must be supplied and qualified by one seller as a subsystem in order to qualify for this bundling relaxation (see Figure 2). This bundling compromise is made by combining the wire bundles that have identical first digits of the EMC code group and qualify for this bundling relaxation.

3.3.1.3 Additional Compromises

If there is difficulty in complying with the above procedures and it cannot be resolved by the compromises, the problems must be brought to the attention of the XY-1A EMC Group. The XY-1A EMC Group will then indicate the additional compromises permissible. All such resolutions will be recorded and filed for future reference.

3.3.2 Supplemental Requirements

In addition to the requirements of 3.3.1.1 the following shall apply.

3.3.2.1 Configurations

When different connector wire bundles, equipment wire bundles, or subsystem wire bundles are combined in a harness, each individual bundle shall be grouped separately within the overall harness as shown in Figure 3. Each bundle shall be located within the harness so that there is maximum separation between the different subsystems.

3.3.2.2 Cross Wiring

Where wiring from different subsystems must cross and the subsystem separation cannot be attained, the cross shall be made at a right angle.

3.3.2.3 Standard Routing Techniques

(a) In areas where more than the minimum wiring separation is possible, all available space shall be used for maximum wiring separation.

(b) In areas where minimum separation requirements cannot be fulfilled, the routing shall use all available space to give maximum possible separation.

(c) All wires passing through physical constraints such as module disconnects shall return to maximum separation as soon as physically possible. Reference Figure 4.

  (1) Metal Troughs – Troughs of suitable metals may be used to provide separation in restricted areas as required.

  (2) Conduit – Conduit of suitable materials may be used in certain restricted areas as a mechanical aid or to provide additional isolation.

(d) All antenna leads must be routed separately in accordance with Specification MIL-W-5088.

(e) Wiring from the left hand generator buss shall be routed separately from the wiring of the right hand generator buss.

3.3.2.4 Module Disconnects

When different equipment wiring or different subsystem wiring must be routed through a module disconnect, the disconnect shall be grouped so that each subsystem wiring is confined to a sector of the disconnect; each equipments wiring within a subsystem is confined to a common subsector; each connector wire bundle of an equipment is confined to an area of the sub-sector (see Figure 5).

3.4 Shield Grounding

Shields, when used, must be grounded at both ends.

3.4.1 Shield Discontinuities

Individual or group shields shall be carried through the connector on a separate pin and grounded at the receiving side of the discontinuity. No more than six shields shall be carried through the connector on one pin. The length of the exposed unshielded wire at the back of the connector shall not exceed two inches.

3.4.2 Common Shield Grounding

Where a common shield ground is used, such as on multishielded cable or in a harness having a large number of individual shields, a heavy conductor, such as a halo or a connector backshell, should be used to ground all the shields to the connector or to the chassis. The length of the exposed unshielded wire at the back of the connector shall not exceed two inches. Shield ground leads shall not exceed two inches when terminated to connector.

3.5 Design Approvals

As required by corporate procedure WCP-68-80D1, the following design approvals shall apply.

3.5.1 Drawings

All electrical/electronic wiring diagram layouts and harness charts shall receive EMC coding. The EMC coded wiring diagrams shall be signed off by the cognizant EMC engineer before their release.

3.5.2 Drawing Revisions

All revisions to the electrical/electronic wiring diagram layouts and harness charts shall be considered as originals and shall receive EMC coding. Drawing revisions shall be signed off by the cognizant EMC engineer before their release.

3.5.3 Mock-Ups

All wiring mock-ups shall be approved as meeting the EMC requirements for separations and routing of harnesses by the XY-1A EMC group before their release.

3.5.4 Aircraft

The XY-1A aircraft shall be approved as meeting the EMC requirements for separation and routing of harnesses by the XY-1A EMC group.

4.0 QUALITY ASSURANCE

4.1 Drawings

The EMC Code Group shall be specified on all wiring diagram layouts and harness charts.

4.2 Tooling

Tool drawings shall be prepared for fabrication of XY-1A harnesses and cable assemblies in accordance with the specified wiring requirements.

4.3 Installation

Photographs and drawings recording wire installations in the XY-1A airplane shall be prepared and filed.

4.4 Monitoring

The XY-1A EMC group sh: . provide complete coverage for the initial installation of wiring into the prototype XY-1A aircraft and any additional new wiring into subsequent aircraft.

4.5 Records

Engineering shall retain copies of all drawings depicting design and installation requirements. Records of all inspection procedures and results shall also be kept.

5.0 PREPARATION FOR DELIVERY

Not applicable.

6.0 NOTES

6.1 Definitions

(a) Subsystem Wiring
All wiring within a particular subsystem group.

(b) Subsystem Separation
Subsystem separation is the distance required between wiring of different subsystems.

(c) Equipment Separation
Distance required to separate an equipment wiring assembly from all other equipment wiring assemblies within a single subsystem.

(d) Connector Separation
Distance required to separate a connector wiring assembly from all other connector wiring assemblies whose signals emanate from the same equipment within a single subsystem.

(e) Special Wire Separation
Wires within a connector that require separation from all other wires within a connector wiring assembly, and whose signals emanate from an equipment within a single subsystem.

(f) Primary Power
Power generated by the airplane's electrical system.

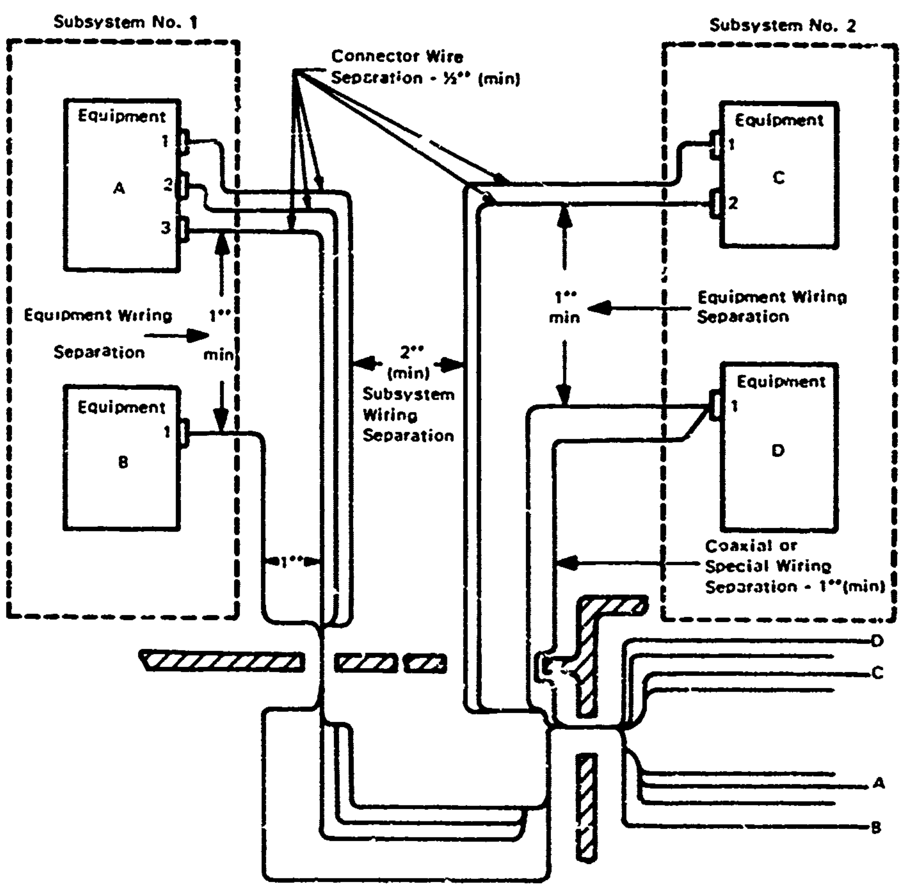


FIGURE 1 - CONNECTOR, EQUIPMENT AND SUBSYSTEM WIRING SEPARATION

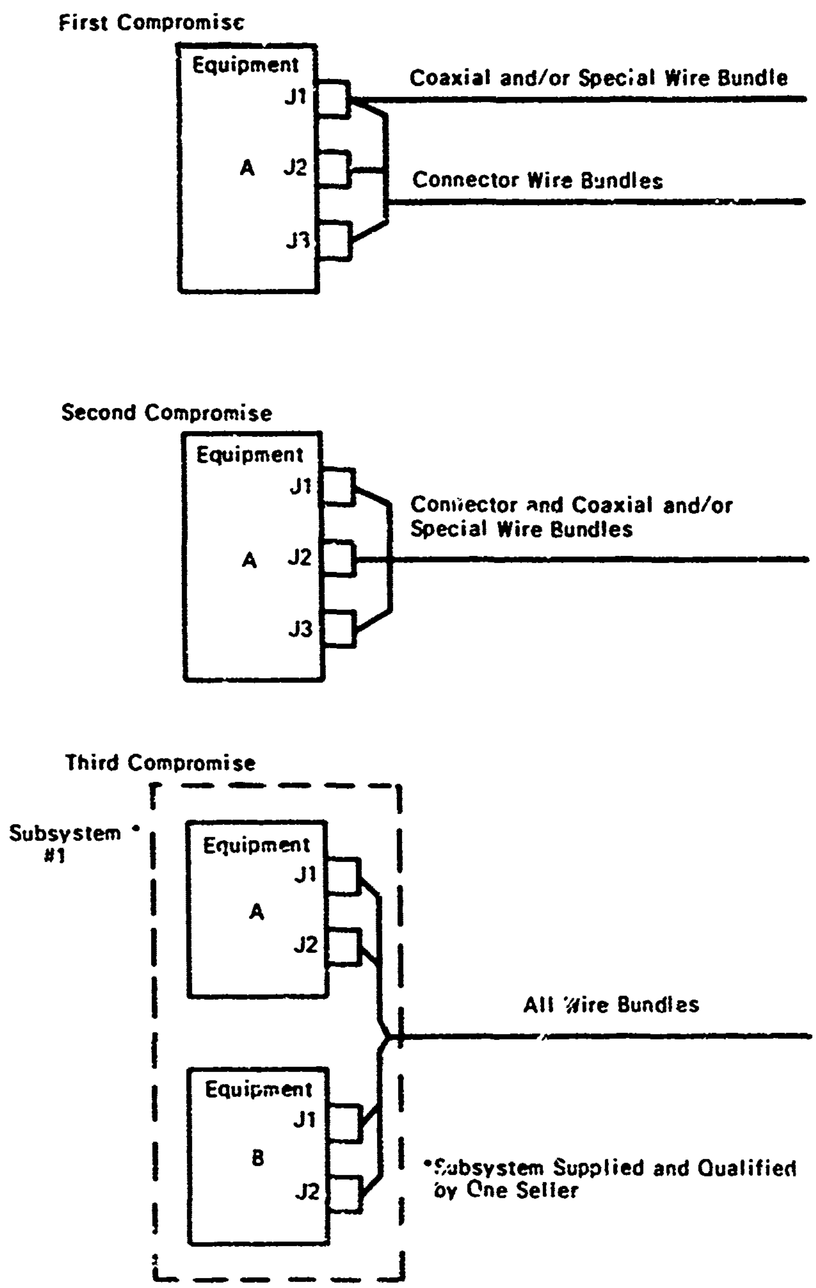


FIGURE 2 SEPARATION COMPROMISES

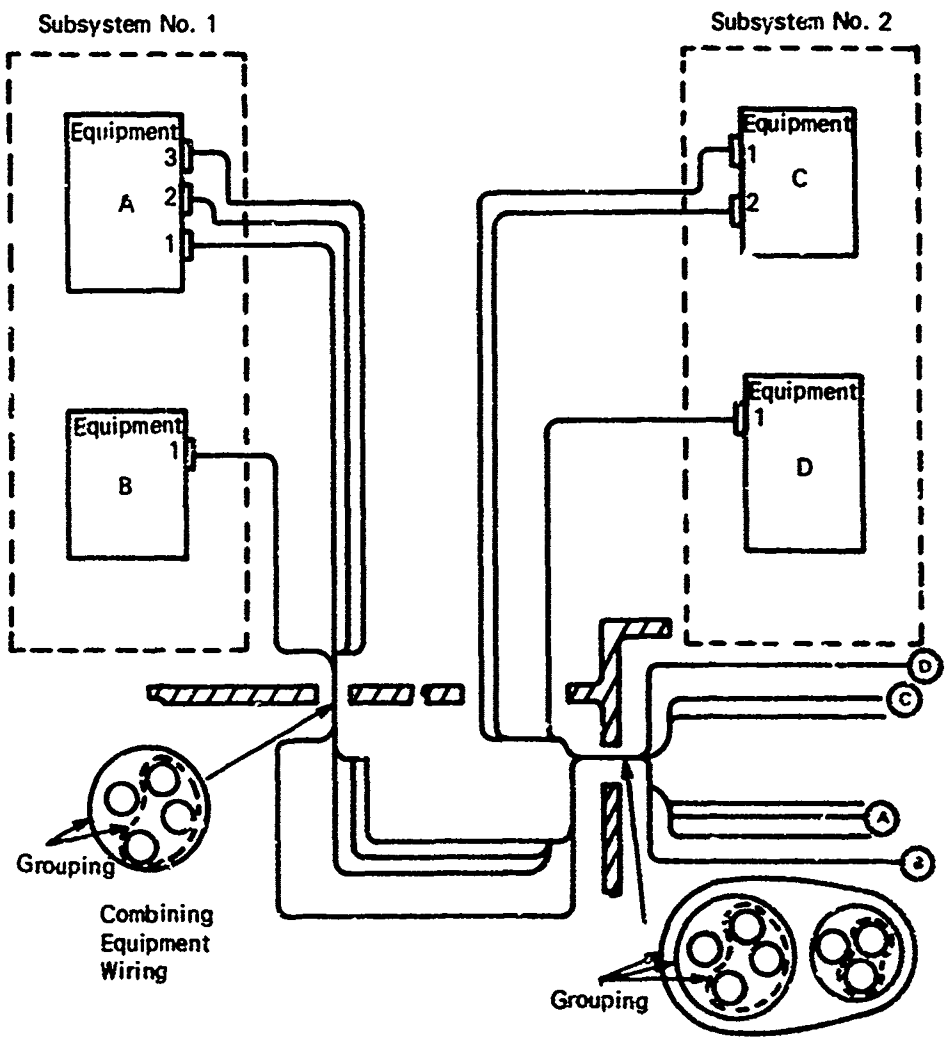


FIGURE 3 TYPICAL HARNESS CONFIGURATION

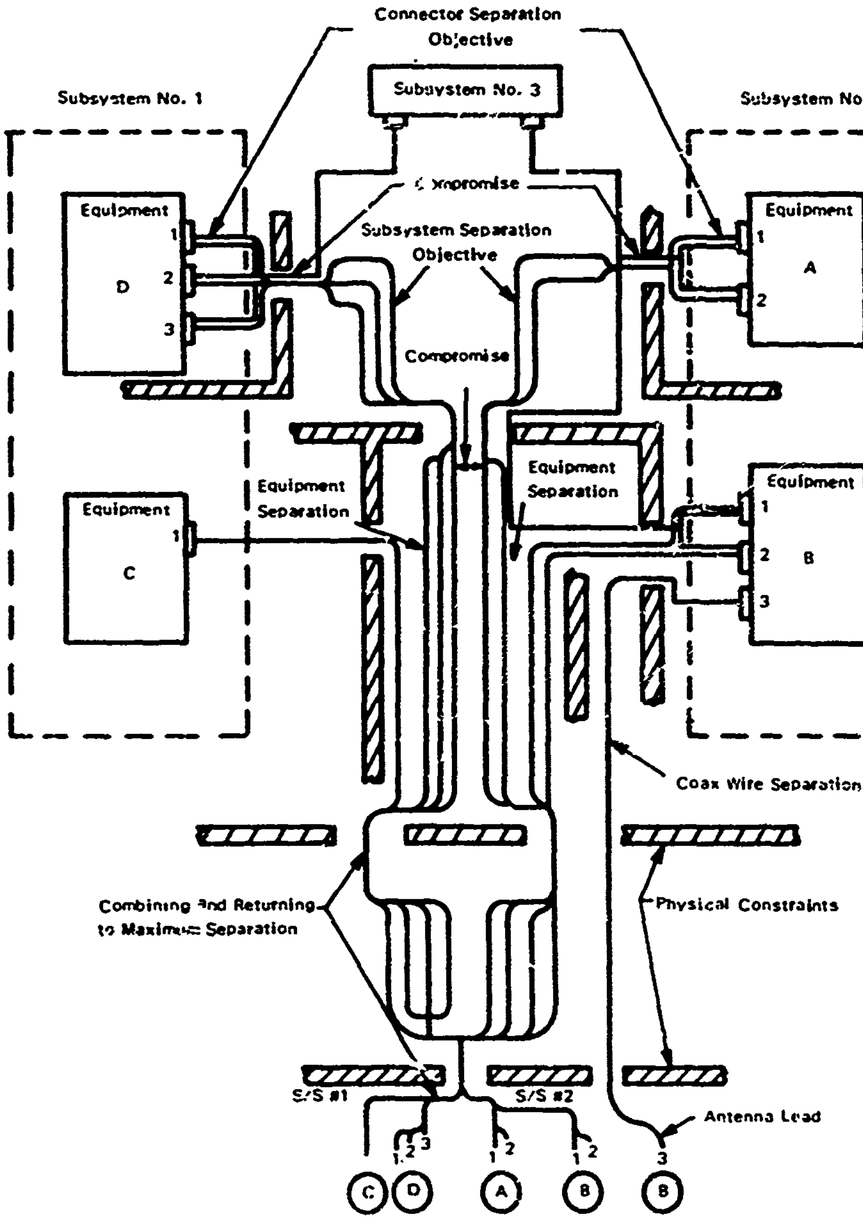


FIGURE 4 - TYPICAL AIRPLANE WIRING CONFIGURATIONS

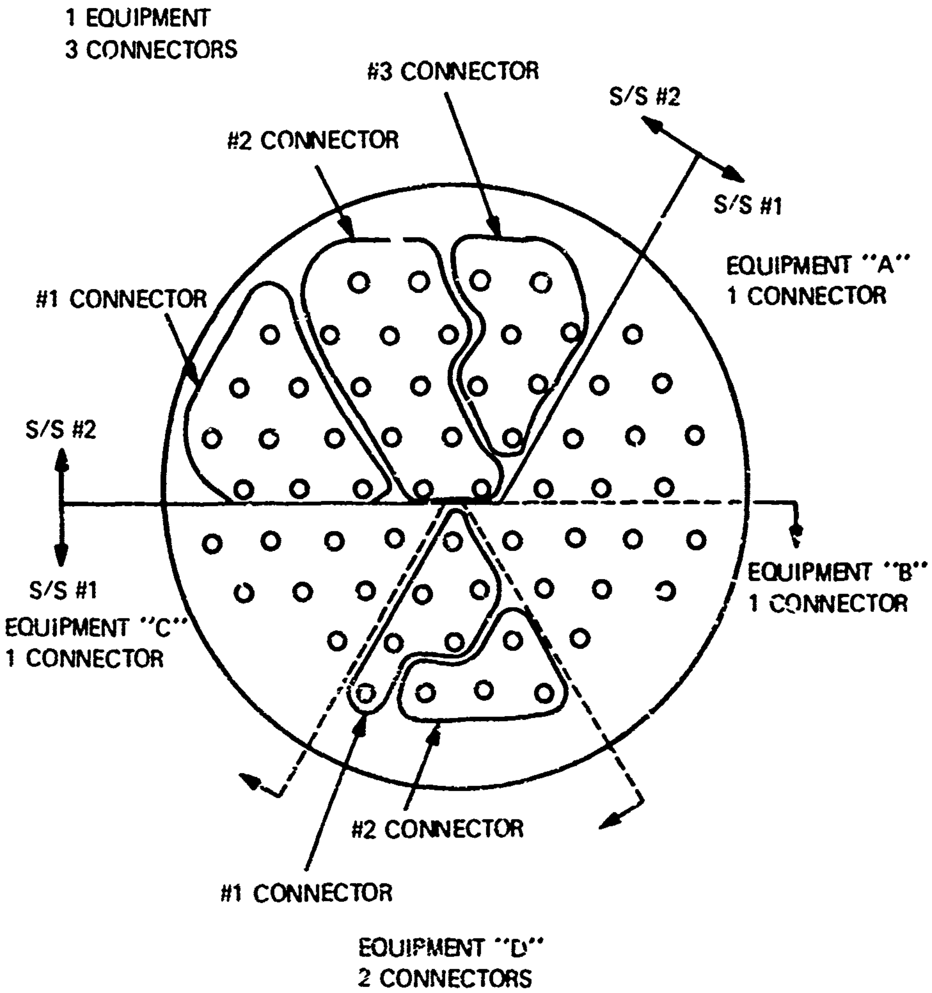


FIGURE 5 MODULE DISCONNECT LAYOUT

REVISION DESCRIPTION

Spec No. SPECEW200

This specification has been revised as stated below and re-issued as of the date shown on the title page. Change descriptions are not cumulative and apply to this revision only. All approved amendments to the previous issue of this specification have been incorporated, showing the authority for each amendment; for specific items and authorities refer to the actual amendments. Authority for all other changes is shown individually.

Page No.	Para No.	Description	Wandow Info	Authority		
			ECP, DR Etc.	Class I	Class II	Gov't.
		The following changes were made to comply with system design and for clarification.		N/	A	
2	2.1	Capitalized all titles of publications.				
5	3.2.1.6	Added an asterisk to each of the three "(connector wire bundle)" phrases. Added "NOTE:"		N/	A	
6	TABLE I	Added equipment nomenclatures and EMC codes to "Instruments" and "Engine Instruments" list.				
19	Figure 4	Deleted existing Figure 4 and substituted new Figure 4.				

WANDOW AIRCRAFT ENGINEERING CORPORATION

PLYMOUTH, PA.

Specification No. SPECEB300

Release Date 14 January 19XX

ELECTRICAL BONDING REQUIREMENTS

GENERAL SPECIFICATION FOR

XY-1A WEAPON SYSTEM

C. White Specifications Engr	M. Blanc Project Engr.
F. Smith Cognizant EMC Engr	W. Schwartz Deputy Engr. Mgr.
R. Brown EMC Dept. Head	A. Jones Support Mgr
J. Dough Project Engr.	B. Greene Engr. Mgr.

ELECTRICAL BONDING REQUIREMENTS
GENERAL SPECIFICATION FOR
XY-1A WEAPON SYSTEM

1.0 SCOPE

1.1 Scope

This specification establishes the requirements for electrical bonding of the XY-1A weapon system to ensure that electrical and electronic installations and overall airframe construction are adequately bonded to effect subsystem and system electromagnetic compatibility, lightning protection, and safety. This document does not supersede or waive any requirements of specification MIL-B-5087. It specifically states the bonding requirements in full accordance with specification MIL-B-5087 and further aids in its intent.

2.0 APPLICABLE DOCUMENTS

2.1 Selection of Specifications and Standards

Applicable publications are those contained in the List of Specifications and Standards (Book Form) Approved by the Naval Air Systems Command, NAVAIR 00-25-544 dated, October 1966: and the List of Standard Drawings Used by the Naval Air Systems Command, NAVAIR 00-25-543, dated March 1967. Other applicable publications not contained in the above lists shall be the issue in effect on 1 May 1968, except as noted herein. All standards and specifications other than those established for use by the Naval Air Systems Command must be approved by the procuring activity before use as a part of this specification.

2.1.1 General

The following documents of the exact issue shown form a part of this specification to the extent specified herein:

SPECIFICATIONS

Military	Titles	Appl. Para.
MIL-M-3171C	Magnesium Alloy, Processes for Pretreatment and Prevention of Corrosion on	Type I
MIL-B-5087B	Bonding, Electrical, and Lightning Protection for Aerospace Systems	All
MIL-C-5541A	Chemical Films for Aluminum and Aluminum Alloys	All
MIL-L-6806	Lacquer; Clear, Aluminum Clad, Aluminum Alloy Surfaces	All

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MIL-D-8706A	Data and Tests, Engineering Contract Requirements for Aircraft Weapon Systems	Addendum 305

STANDARDS

Military	Titles	Appl. Para.
MS25083	Jumper Assembly, Electric, Bonding and Current Return	All

3.0 REQUIREMENTS

3.1 General

The requirements specified herein are to insure that all pieces of metal are electrically bonded to each other. These requirements apply to the overall aircraft construction and each electrical and electronic installation. Compliance to these requirements is essential to subsystem and system compatibility and to provide electrical stability so that all installations shall be free from the hazards of lightning and electrical shock.

Any deviations from the requirements stated herein shall require Wandow XY-1A Electro-Magnetic Compatibility (EMC) Group approval.

3.1.1 Design Responsibilities

The cognizant engineers and designers shall be responsible for the inclusion of electrical bonding provisions on engineering drawings and production data both for contractor's designs and those of the Wandow in-house effort. Bonding requirements shall be referenced on all assembly drawings. These bonding requirements shall specify the applicable paragraphs and/or figures of referenced specifications as well as the maximum allowable electrical resistance of each bond.

3.1.2 Design Requirements

3.1.2.1 Electrical Resistance of Bonds

The electrical resistance across any bonded joint or connection in an electrical or electronic installation such as jumper terminal to structure and structure to structure shall not exceed 0.0025 ohm. This measurement shall be made with a Biddle "Ductor" low resistance ohmmeter or an equivalent.

3.1.3 Bonding Considerations

3.1.3.1 Parts Inherently Bonded

Metal-to-metal joints meet bonding requirements when they comply with the following descriptions:

(a) Permanent metal-to-metal joints formed by welding, brazing, sweating, or swaging.

(b) Semi-permanent, machined, electrically cleaned metal-to-metal joints held together by thread-locking devices, rivets, tie rods, structural rods under heavy tension, or pinned fittings driven tight and not subject to wear.

(c) Normally permanent and immovable, electrically clean metal-to-metal joints held together by clamped fittings.

An electrically clean metal-to-metal joint is formed by removal before assembly of all electrically insulating finishes and coatings, including alodine, iridite, or equivalent, from the contact surfaces of the materials being joined.

3.1.3.2 Extent of Bonding

The number of bonding jumpers to be installed shall be kept to a minimum. The necessity for, and the location of, all bonding jumpers shall be approved by the Wandow XY-1A EMC Group.

3.1.3.3 Parts Impractical to Bond With Jumpers

Where bonding is necessary but bonding by jumper may cause fouling or mechanical malfunction, other suitable means of bonding shall be used. Bonding of this nature shall be effected in accordance with good engineering practice and shall be subject to the approval of the Wandow XY-1A EMC Group.

3.1.3.4 Protrusions Bonding

All external electrically isolated conducting objects, excluding antennas, which protrude above the vehicle surface shall have a bond to the vehicle skin or structure. Large nonconducting projections essential to flight or housing personnel, such as vertical stabilizer parts, wing tips astrodomes, and canopies, shall have the lightning path externally distributed over their exposed area leading to the vehicle skin. Vehicle flight safety, flight characteristics, crew visibility, and equipment performance shall take precedence over these requirements. The conductive path shall not affect the structural integrity of the projection. If a semiconducting surface or nonlinear-graded surface resistance is used to initiate a lightning path, the voltage gradient at any point along the path to the skin shall be less than the breakdown gradient to any grounded object within, and the resistive path shall be at least 1 inch wide.

3.1.4 GFE and Standard Equipment

Government-furnished or off-the-shelf standard equipments that cannot be adequately bonded to their respective shock mounts shall be referred to the Wandow XY-1A EMC Group so that methods of complying with applicable bonding requirements of this specification may be determined. Government-furnished equipment having inadequate case bonding shall be brought to the attention of the Wandow XY-1A EMC Group.

3.2 Materials

3.2.1 Bonding Connections

3.2.1.1 Preferred Straps

Bonding straps shall not exceed a length-to-width ratio of 5:1 and shall be as short as possible (reference Figure 1). Any variation from this standard must be approved by the Wandow XY-1A EMC Group.

3.2.1.2 Acceptable Straps

Bonding jumpers per MS25083 are acceptable when the preferred straps cannot be used.

3.2.2 Connection Finishes

All connectors shall be provided with an electrically conductive coating.

3.2.3 Titanium Interfaces With Aluminum

All titanium to aluminum bonding shall be done using a solid nickel lug interface.

3.3 Fabrication

3.3.1 Fabrication Responsibilities

It shall be the responsibility of fabrication, installation, and inspection personnel to determine that the bonding requirements specified by engineering drawings and this specification are met on each electronic component and installation.

3.3.2 Bonding, Current Return

Adequate electrical bonding is necessary between articles of equipment and the basic aircraft structure to provide a low resistance path. Bonding provisions must provide a suitable power return path and must fall into one of the following classes:

(a) Class "A" – Permanent Type

Bonding jumper as shown in Figures 2, 3, 4, and 5.

(b) Class "B" – Detachable Or Stud Type

In this type of installation, the connection to structure takes the form of a through stud. Bearing against structure is carried through a flat washer with a star washer (AN936) between the structure and the head of the screw. Contact areas on structure shall be prepared in accordance with 3.5, before assembly. With the stud tightened in place, the structure and the intersection of the aluminum washers and the structure is refinished according to the general airplane finish schedule. This electrical connection may be disconnected at will. Stud-hardware shall be as noted on applicable drawings. (See Figure 6)

(c) Class "C" – Heavy Duty Ground

This type of connection may in some instances be required. It involves the use of a tab of large enough section to carry the currents involved. The tab, unanodized and prepared in accordance with 3.5, is placed against structure, also prepared in accordance with 3.5, and riveted by at least three 1/8 rivets, or bolted in 2 places. The connection area, including the joint, is to be refinished according to the general airplane finish schedule. The portion of the tab projecting from the structure is to remain clean to allow good electrical connection to be made. Terminations shall be torqued to the values listed below. (See Figure 7)

NUT TORQUE

SIZE	MINIMUM TORQUE INCH LBS.	MAXIMUM TORQUE INCH LBS.
1/4	40	60
5/16	65	95
3/8	95	110

3.3.3 Bonding of Antenna Installation

Antenna mounting bases and airframe mating surfaces shall be prepared to comply with the requirements set forth in 3.5. When required, special bonding limits for antenna installations shall be specified on the applicable antenna drawing.

3.3.3.1 Bonding of Panels

Particular attention shall be given to the bonding of panels adjacent to antennas. When an adjoining panel is required for an adequate ground plane, the entire mating width of the belt frame and the surfaces of the panels that mate with this belt frame shall be prepared in accordance with the requirements in 3.5 of this document. When these panels are of sandwich type construction, consideration shall be given to electrically bonding the inner surface to the outer surface. Non-anodized rivets at 0.5-inch spacing will provide adequate electrical bonding of the two surfaces.

3.3.4 Bonding and Explosive Fuel Areas

In areas where hazardous conditions are caused by the presence of explosive fuels and gasses, bonding shall be done to prevent ignition in the event of power faults. Resistance of fault-current bonding, such as from equipment or component case to structure, shall not exceed the values shown in Figure 8 for each bond connection.

3.3.5 Metal Electrical and Electronic Racks and Drawers

Rack and panel type equipment shall be bonded between the equipment and the rack by bare, clean, metal-to-metal contact, and the rack shall be bonded to the basic aircraft structure by bare, clean, metal-to-metal contact. Spot cleaning at screw holes is acceptable when approved by the Wandow XY-1A EMC

Group. Adjoining or faying surfaces shall also be prepared as specified in 3.5, with the following applications:

- (a) Detailed rack or drawer structure (Figures 9 through 12)
- (b) Attachment of connector alignment pins (Figure 10)
- (c) Attachment of drawer latches (Figures 9 and 11)
- (d) Mounting of special fasteners (Figure 11)
- (e) Equipment mounting surfaces and brackets (Figure 13)
- (f) Mounts of aluminum electrical connector shells (Figure 14)
- (g) Structure and skin isolated by adhesives (Figures 15 and 16)

3.3.6 Bonding of Boron Composite Structures

Boron composite surfaces shall be prepared for adequate protection against damage due to lightning. After preparation, the boron composite surfaces shall be attached to the main structural support members by metal rivets. The boron composite structures and other surfaces of the aircraft shall be bonded together by bonding straps.

3.3.7 Bonding of Titanium to Aluminum

Titanium shall be bonded to aluminum by the use of a solid nickel lug on the bonding jumper between the titanium and aluminum. (Figure 17).

3.4 Installation

3.4.1 Installation Responsibilities

Designers of equipment installations shall include provisions for electrical bonding to meet the intent of this specification with respect to low impedance bonding. The installation in the aircraft shall provide a low impedance bonding and a low impedance path between the equipment mounting surfaces and the basic airframe structures. The equipment cases, shields, and mounting surfaces shall be provided with a low impedance path between the equipment and the external case and its mounting surfaces.

3.4.2 Precipitation Static Discharger Bonding

Static dischargers shall have a resistance not to exceed 0.2 ohm between the base of the static discharger and the aircraft structure as measured with a Biddle "Ductor" low resistance ohmmeter (reference Figure 18) or an equivalent.

3.4.3 Control Surfaces and Flaps; Lightning Protection

To provide for lightning protection, control surfaces and flaps shall have a bonding jumper across each hinge, and in any case shall not have fewer than two jumpers.

3.4.4 Unit Removal

Fabrication, installation, and inspection personnel shall determine that no degradation in bonding provisions have occurred as a result of removal of any unit for any reason.

3.5 Preparation and Refinishing of Bonding Surface Material

3.5.1 Surface Preparation for Electrical Contact

Mating surfaces shall be cleaned of anodic flim, oxides, greases, paints, lacquers, or other highly resistant films. Surfaces shall be cleaned with carbon steel or stainless steel rotary bonding brushes and then wiped clean with a dry cloth. Care shall be taken to prevent excessive removal of metal. Abrasives such as emery or sandpaper, which are corrosive if particles embed themselves in the metal, shall not be used. (See Figures 1 through 5, 9 through 14, and 19 through 23).

3.5.1.1 Criteria for Partial Cleaning of Mating Surfaces

Mating surfaces shall be partially or spot cleaned when both of the following conditions are present:

(a) The distance between centers of securing devices such as rivets, spot welds, and pin fittings exceeds 2.0 inches

(b) The thickness of either or both of the mating surfaces is .063 inch or less

When the distance between centers of the securing devices is 2.0 inches or less, the entire mating surface shall be cleaned. The diameter of the area to be cleaned shall be at least 1-1/2 times the diameter of the hole for the particular securing device. Specific problem areas shall be referenced to the Wandow XY-1A EMC Group for resolution.

3.5.2 Application of Conductive Coatings

Where corrosion protection is required and resistance requirements can be met, conductive coatings will be selected and applied in accordance with Specification MIL-C-5541. Conductive coatings that do not meet the resistance requirements of a maximum resistance of 0.0025 ohms shall not be used unless approved by the Wandow XY-1A EMC Group.

3.5.2.1 Refinishing

When it has been necessary to remove any protective coating on metallic surfaces to conform with this specification, the completed assembly shall be refinished, as shown herein, with its original finish or one of the following protective finishes, within 24 hours after inspection:

(a) Brush zinc chromate paste over the remaining bare areas

(b) Brush either zinc chromate primer or epoxy prime. plus the original finish over the remaining bare areas

(c) A clear finish conforming to Specification MIL-L-6806 may be used, if desired, to facilitate subsequent inspection

(d) For finish on all fuel lines, use brush alodine

3.6 Aircraft Static Ground

A suitable ground connector shall be provided for connection of a static ground when the aircraft is on the ground.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 General

Fabrication, installation, and inspection personnel shall determine that the bonding requirements specified by engineering drawings, standards and this specification have been met. This shall be assured by visual inspection of surfaces before and after installation. Careful attention shall be given to the removal and replacement of any electrical and electronic equipment and mounting surfaces to assure that replaced units are properly bonded. A standard procedure shall be established and used whereby a visual inspection check shall be performed whenever any electrical and electronic equipment or bonded surfaces are removed and replaced before the installation is accepted by the inspection department. This procedure shall include a means for documenting this inspection check.

4.2 Resistance Bonding

Resistance measurements to prove satisfaction of the bonding requirements of this specification shall be performed on at least two end items representative of any particular model. Thereafter, additional measurements shall be made only when a change in design or construction is introduced. Visual inspection shall be conducted on all end items to determine that no changes were made in methods or material, different from that of the test items, that would affect conformance to this specification.

4.3 Lightning Protection Tests

Laboratory tests of lightning protection provisions for external sections, such as radomes, antennas, control surfaces, and canopies, shall be performed to demonstrate adequate protection.

4.4 Test Procedures

Test procedures and techniques shall be generated to satisfy 4.2 and 4.3 of this specification.

4.5 Test Reports

Test reports shall be generated to document the results of the tests performed in 4.2 and 4.3 of this specification. These test reports shall be submitted to NAVAIR in accordance with specification MIL-D-8706, Addendum 305.

5.0 **PREPARATION FOR DELIVERY**

Not applicable

6.0 **NOTES**

6.1 Definitions

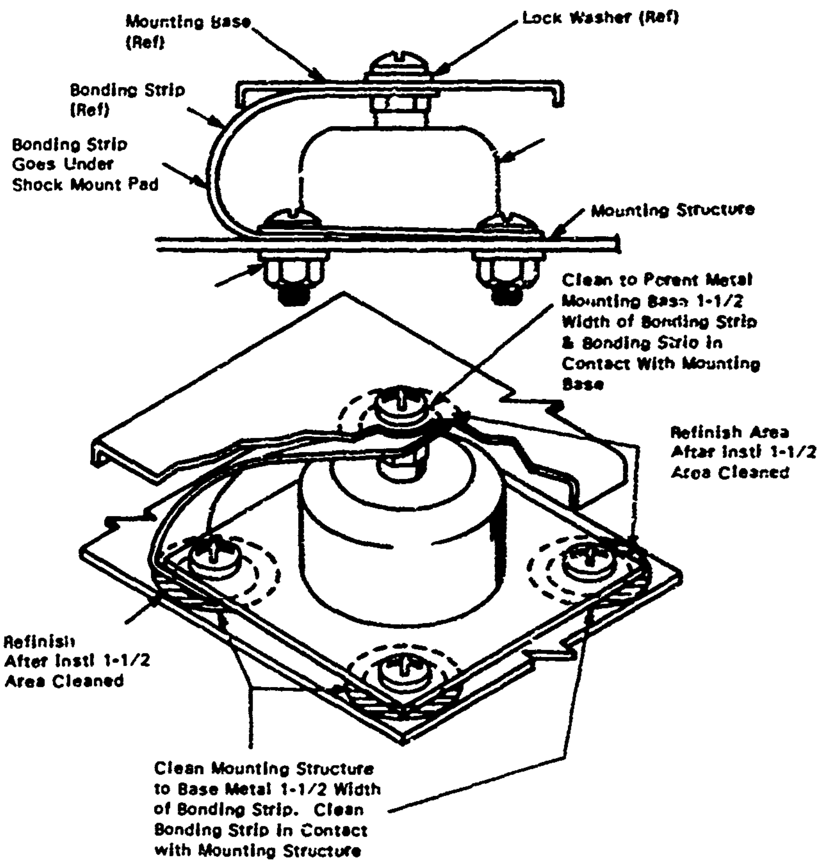
(a) Bond
A bond is any fixed union between two metallic objects that results in electrical conduction between the objects having a resistance value equal to or less than specified in this document. Such union results either from physical contact or the addition of a firm electrical connection between conductive surfaces of the objects. The physical characteristics of the bond shall meet the requirements of this document.

(b) Bonding
Aircraft electrical bonding is the process of obtaining the specified electrical conductivity between the bonded surfaces.

(c) Bonding Connector
A bonding connector provides the specified physical characteristics and electrical conductivity between metallic parts in an airplane that would not otherwise be in sufficient electrical contact. Examples of bonding connectors are bonding straps and bonding jumpers.

(d) Conducting Surfaces or Objects
Conducting surfaces or objects, for the purpose of this specification, include all objects having a resistivity that does not exceed one megohm-centimeter.

(e) Isolated Surface or Objects
For the purpose of this specification, an isolated conducting object is one that is electrically separated by intervening insulation from the airplane structure and from other conductors bonded to the structure.



NOTES:

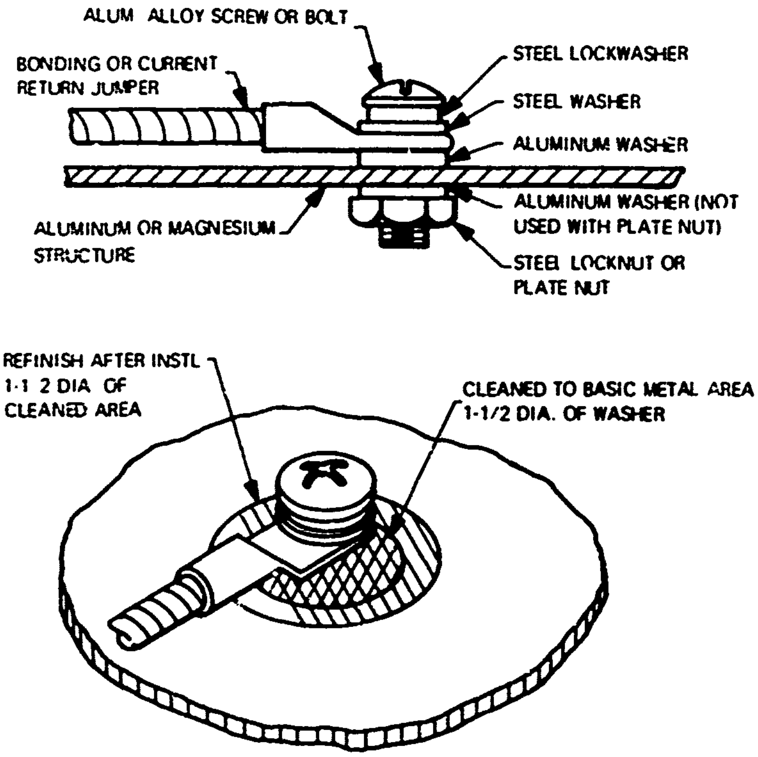
1. Install bonding strip under shock mount pad in such a manner that the strip does not alter shock mount function.
2. Clean and refinish in accordance with 3.5.
3. It is the responsibility of the engineering group doing the installation drawing to see that mounting structure is properly bonded.
4. All riveted elements of the shock mount shall bond. If elements of the mount do not bond, mount shall be disassembled, bonded in accordance with Figure 22 and reassembled.

FIGURE 1 - INSTALLATION OF BONDING STRIPS ON SHOCK MOUNTS

BOLT SIZE:

BONDING - NO 6 & NO 8 SCREW WHERE EDGE DISTANCE WILL NOT PERMIT NO 10 SCREW
- 3/16-INCH DIA MIN WHERE POSSIBLE

100-AMP RETURN 1/4-INCH DIA MIN
200-AMP RETURN-5/16-INCH DIA MIN } See 3.3.2 herein



NOTES:

1. Clean and refinish in accordance with 3.5.
2. Location of nut or head of bolt is optional.
3. Electrical bonding to magnesium alloy structure for current return is prohibited.
4. Either heavy or light series washers shall be used depending upon design detail on engineering drawing

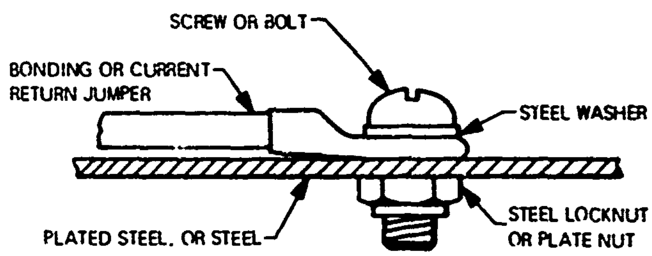
FIGURE 2 BOLTED CONNECTION JUMPER TO ALUMINUM OR MAGNESIUM ALLOY STRUCTURE

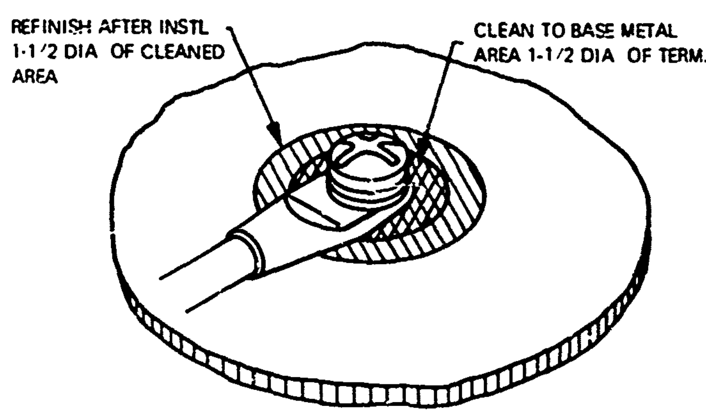
SPECIFICATION
No. SPECEB300

BOLT SIZE:

BONDING - NO. 6 & NO. 8 SCREW WHERE EDGE DISTANCE
WILL NOT PERMIT NO. 10 SCREW
- 3/16-INCH DIA. MIN. WHERE POSSIBLE

100-AMP CURRENT RETURN-1/4-INCH DIA. MIN.
200-AMP CURRENT RETURN-5/16-INCH DIA. MIN. See 3.3.2 herein





NOTES:
1. Clean and refinish in accordance with 3.5.
2. Location of nut or head of bolt is optional.
3. Either heavy or light series washers shall be used, depending upon design detail on engineering drawing.

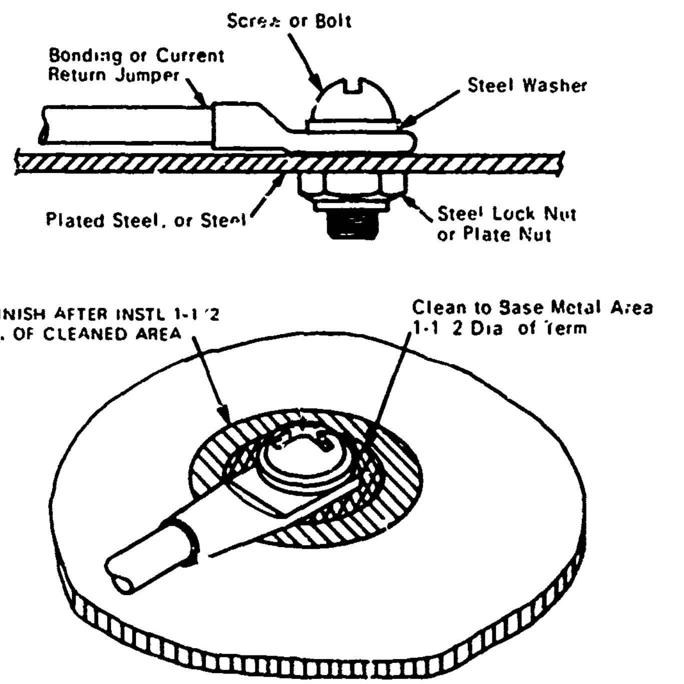
FIGURE 3 BOLTED CONNECTION JUMPER TO ALLOY STEEL

SPECIFICATION
No. SPECEB300

BOLT SIZES:

BONDING - 3/16 INCH DIA MIN

100-AMP - CURRENT RETURN 1/4-INCH DIA. MIN
200-AMP - CURRENT RETURN 5/16-INCH DIA MIN   See 3 3 2 herein

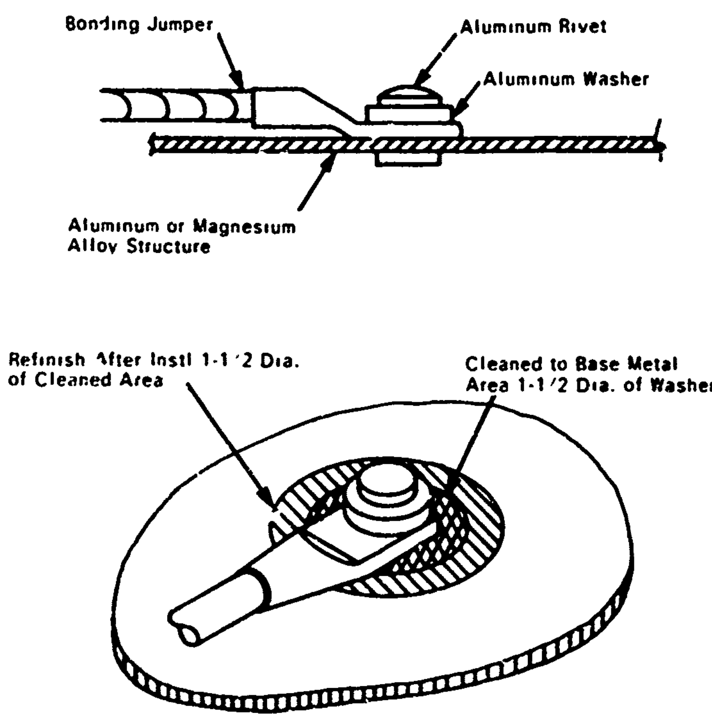


NOTES:

1 Clean and refinish in accordance with 3 5.
2 Location of nut or head of bolt is optional.
3 No refinish required where maximum temperature exceeds 600°F
4 Either heavy or light series washers shall be used. depending upon design detail on engineering drawing

FIGURE 4 BOLT CONNECTION - JUMPER TO CORROSION RESISTANT STEEL

SPECIFICATION
No. SPECEB300



NOTES:

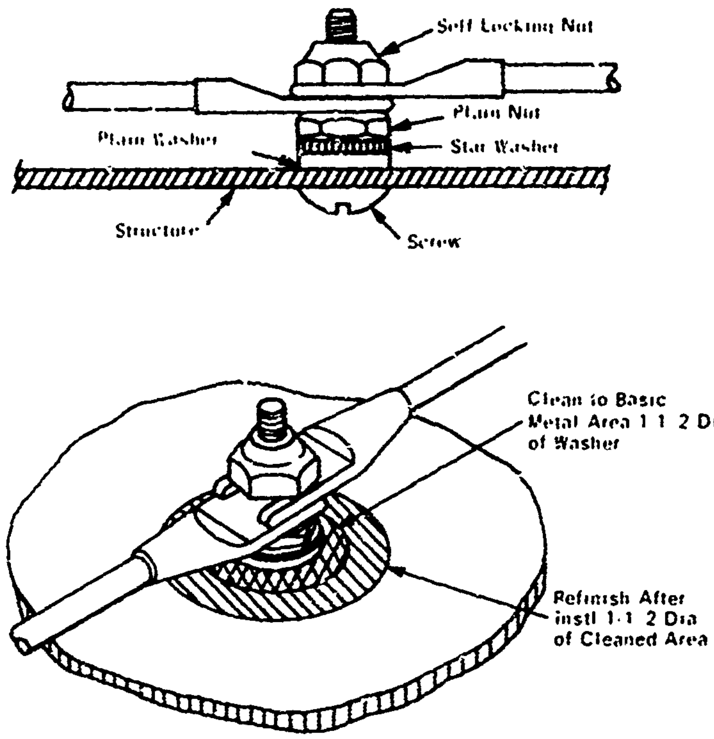
1. Clean, and refinish in accordance with 3.5
2. Do not use existing rivet for attachment
3. Applicable to bonding jumpers not used for current return.
4. Use bolted connections where jumper is used for current return

FIGURE 5 RIVETED CONNECTION - JUMPER TO ALUMINUM OR MAGNESIUM ALLOY

BOLT SIZE

BONDING NO. 6 AND NO. 8 SCREW WHERE EDGE DISTANCE WILL NOT PERMIT NO. 10 SCREW

100 AMP RETURN 1/4 INCH DIA MIN
200 AMP RETURN 5/16 INCH DIA MIN } See 3.3.2 Herein



NOTES.

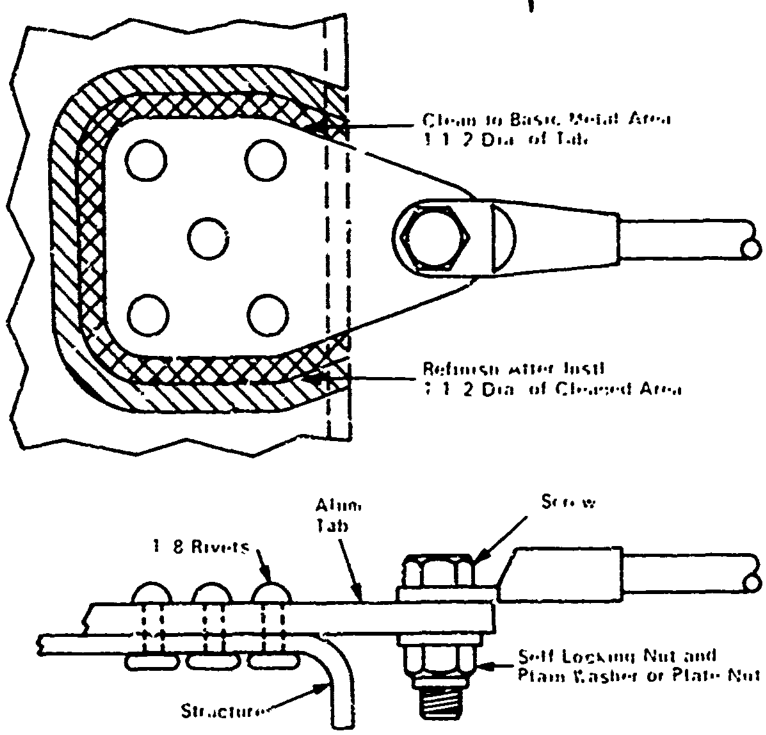
1. Clean and refinish in accordance with 3.5
2. Location of nut or head of bolt is optional
3. Either heavy or light series washers shall be used depending upon design detail on engineering drawing

FIGURE 6 CLASS "B" DETACHABLE OR STUD TYPE GROUND

BOLT SIZE:

BONDING - NO. 6 AND NO. 8 SCREW WHERE EDGE DISTANCE WILL NOT PERMIT NO. 10 SCREW
- 3/16 INCH DIA. MIN. WHERE POSSIBLE

100 AMP CURRENT RETURN 1/4 INCH DIA. MIN.
200 AMP CURRENT RETURN 5/16 INCH DIA. MIN. } See 3.3.2 Herein



NOTES:

1. Clean and refinish in accordance with 3.5.
2. Location of nut or head of bolt is optional.
3. Either heavy or light series washers shall be used depending upon design detail on engineering drawing.

FIGURE 7. CLASS "C" HEAVY DUTY GROUND

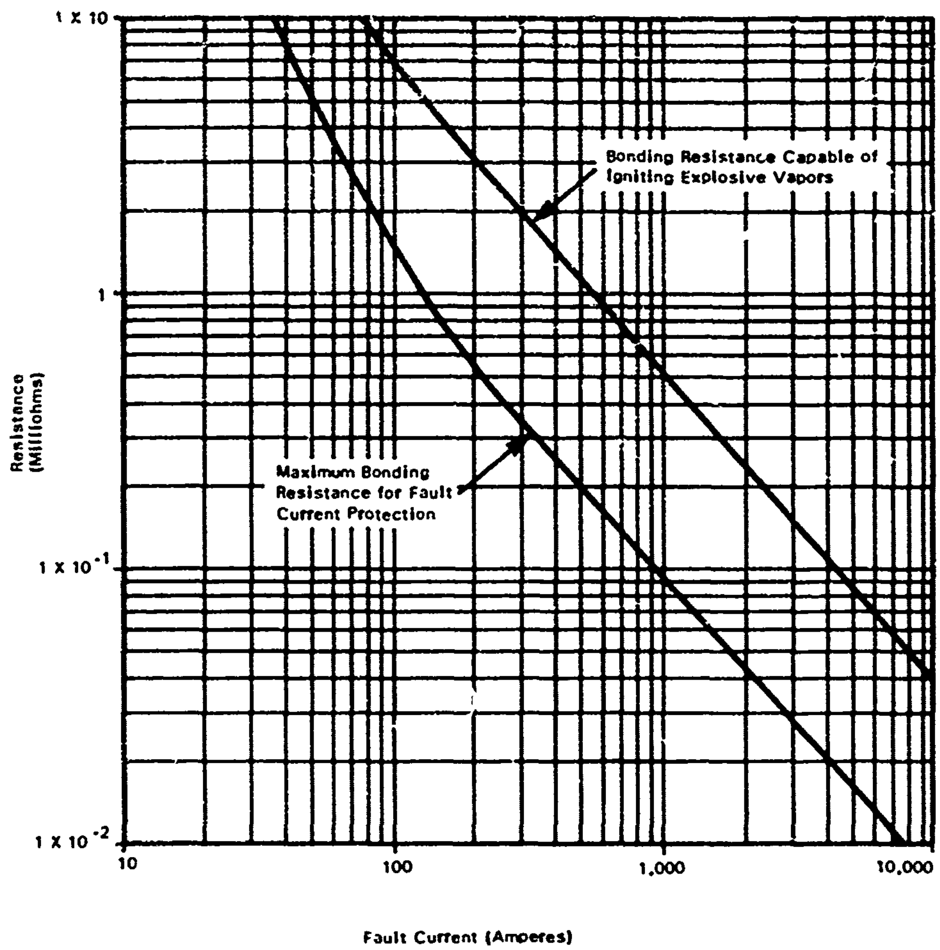
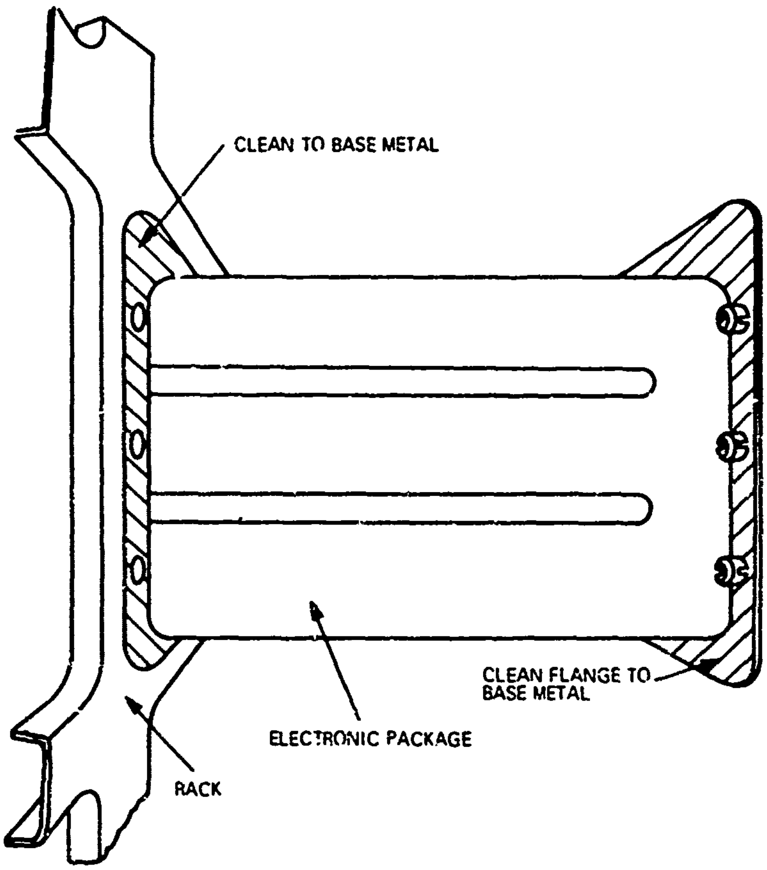
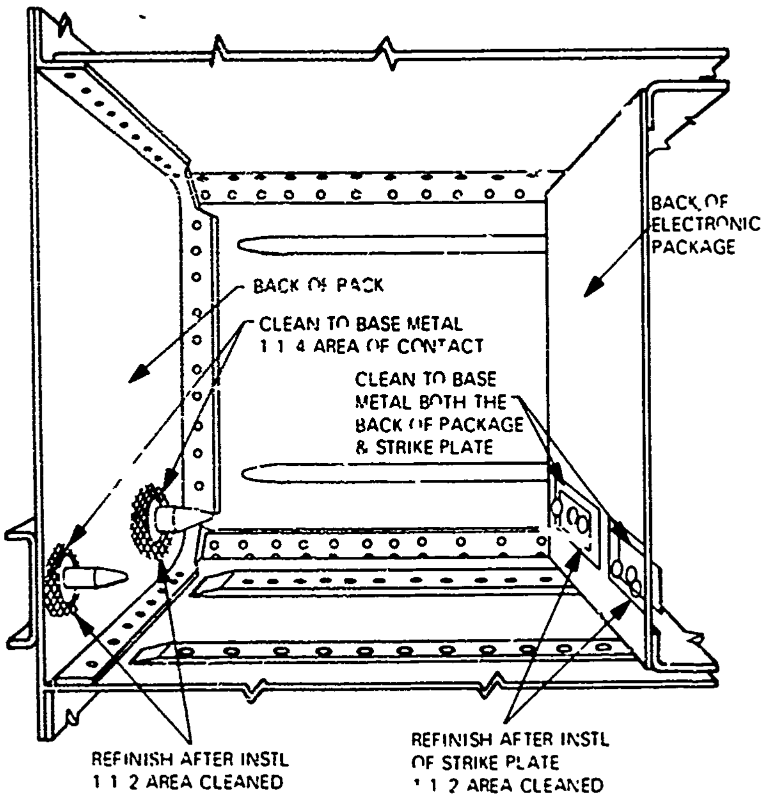


FIGURE 8 - FAULT CURRENT VS MAXIMUM ALLOWED RESISTANCE FOR BONDING BETWEEN EQUIPMENT AND STRUCTURE



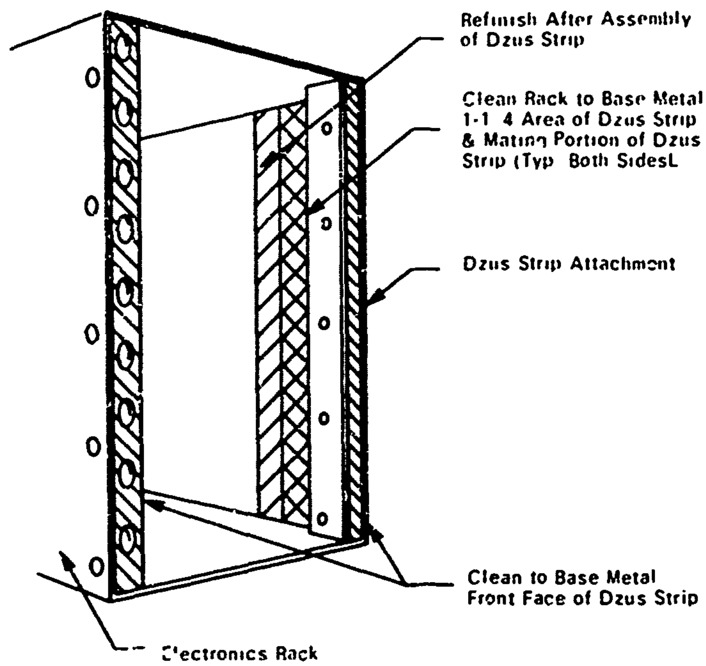
NOTE:
1 Clean and refinish in accordance with 3 5.

FIGURE 9 METHOD OF BONDING BETWEEN ATTACHING FLANGE OF ELECTRONIC PACKAGE AND RACK



NOTES:
1 Clean and refinish in accordance with 3 5
2 All dagger pins and strike plate holes to be cleaned after installation

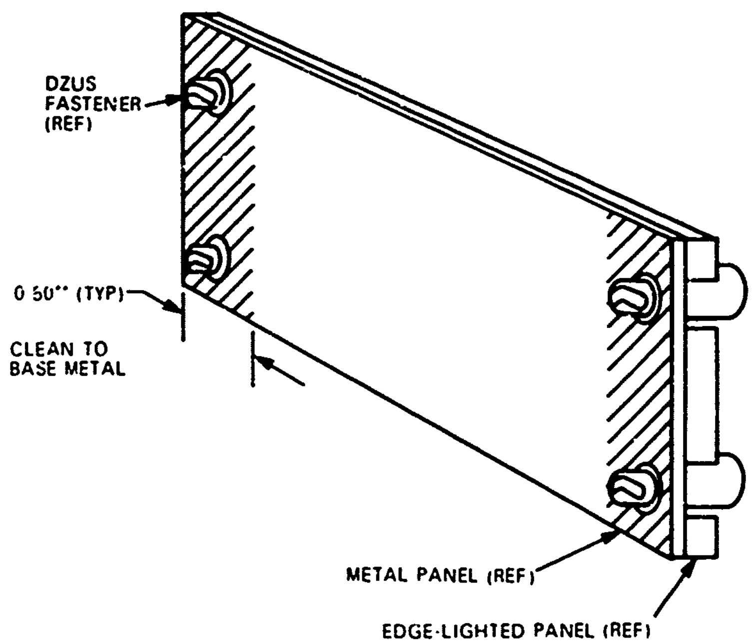
FIGURE 10 TYPICAL METHOD OF BONDING WITH DAGGER PINS



NOTES:

1 Clean and refinish in accordance with 3 5.
2 Electronics package flange that mates with the Dzus strip comply with 3 5 2 herein.
3 Front face of Dzus strip shall be refinished with 3 5 2 herein

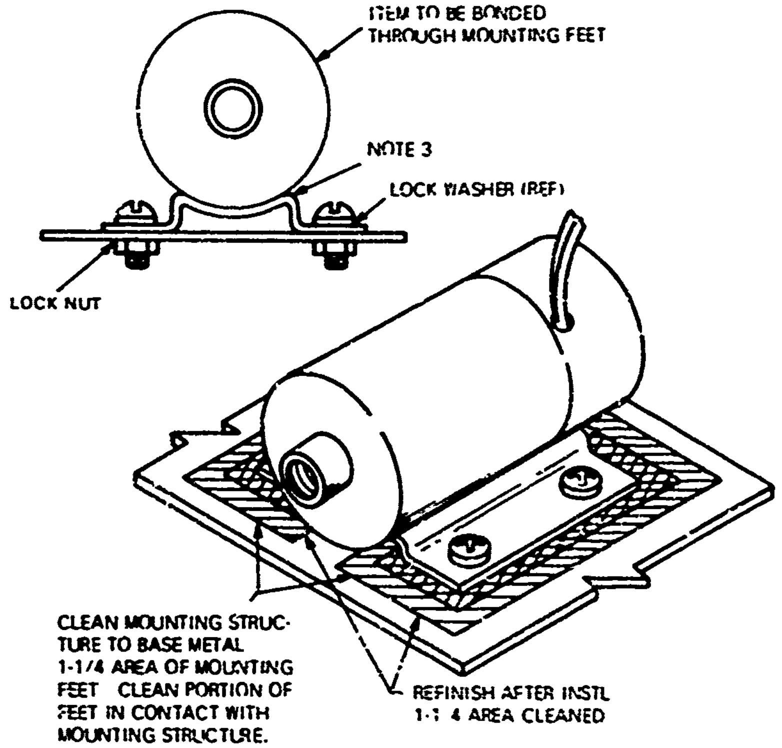
FIGURE 11 METHOD OF BONDING ELECTRONIC PACKAGE TO RACK THROUGH FRONT ATTACHMENTS



NOTE:

1 Clean and refinish in accordance with 3.5.2

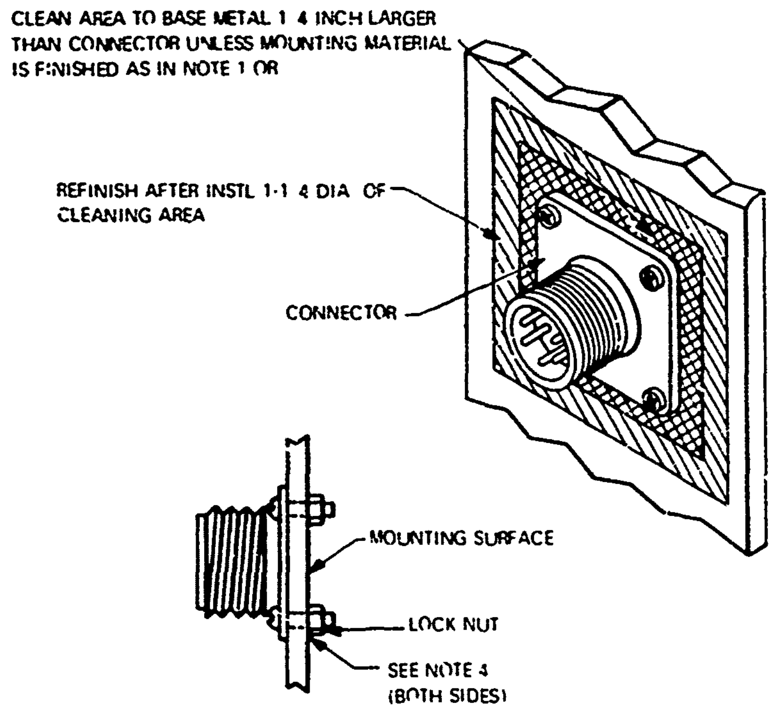
FIGURE 12 METHOD OF BONDING EDGE-LIGHTED PANELS



NOTES:

1. Clean and refinish in accordance with 3 5
2. It is the responsibility of the engineering design group doing the installation drawing to see that the mounting structure is electrically bonded to the airplane
3. It is the responsibility of the group following vendor equipment to see that the vendor complies with these requirements

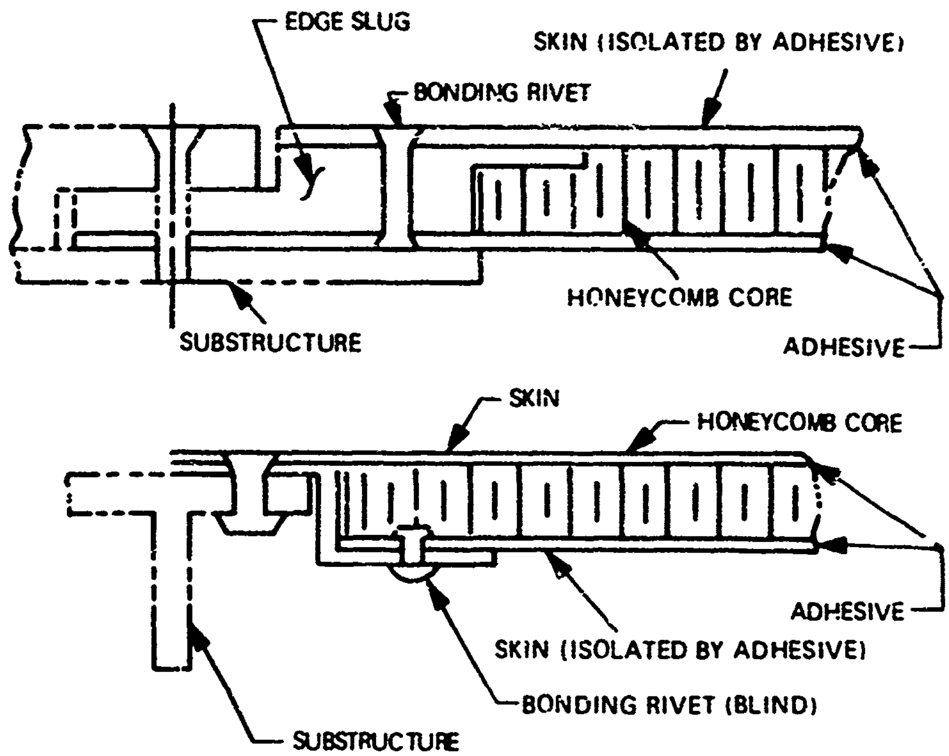
FIGURE 13 BONDING OF EQUIPMENT INSTALLED ON STRUCTURE WITH MOUNTING FEET



NOTES:

1. Aluminum surface mating with connector shall be finished in accordance with 3.5.
2. Magnesium surface mating with connector may be finished with chrome picale conforming to Specification MIL-M-3171, Type 1.
3. It is the responsibility of the group following vendor equipment to see that the vendor complies with these requirements.
4. For bonding to disconnect brackets, spot cleaning at screw holes and refinish in accordance with 3.5 is acceptable when approved by the Wandow XY-1A EMC Group.

FIGURE 14 METHOD OF BONDING CONDUCTIVE CONNECTORS TO ATTACHING PART



NOTES:

1. These diagrams show typical use of rivets for electrical bonding of adhesive isolated details. Joints such as these shall be treated as individual cases and all details shall be specified on the installation drawing.

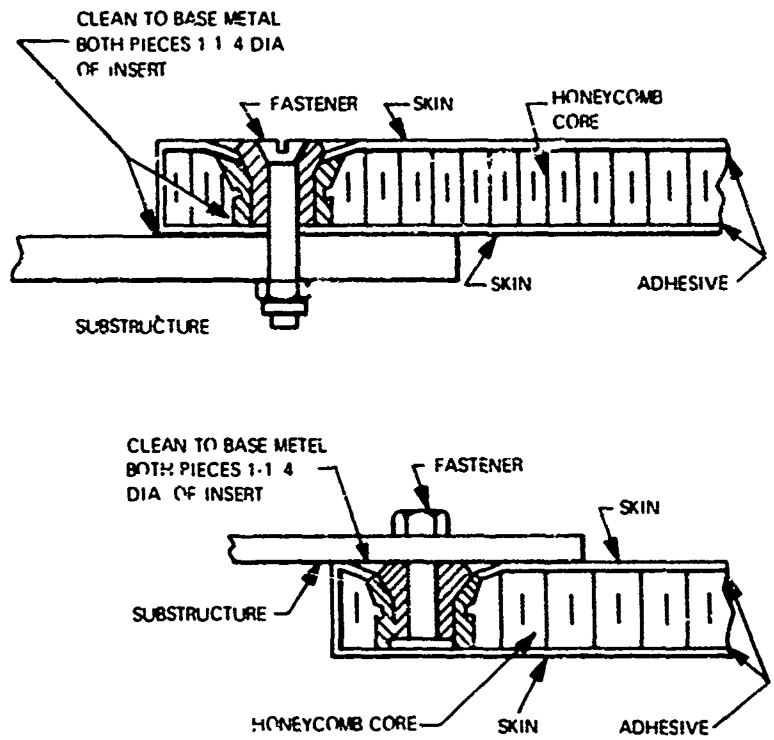
2. Use a minimum of two rivets (total area electrically equivalent to two 1/8" diameter rivets) for any one connection. The total number of rivets and rivet spacing shall be shown on the installation drawing.

3. All rivets shall be drilled for and installed after adhesives are cured.

4. Metal details which are completely shielded by other metal parts will not require electrical bonding.

5. Bond assemblies isolated by nonconducting faying strips to the substructure with rivets or steel bolts.

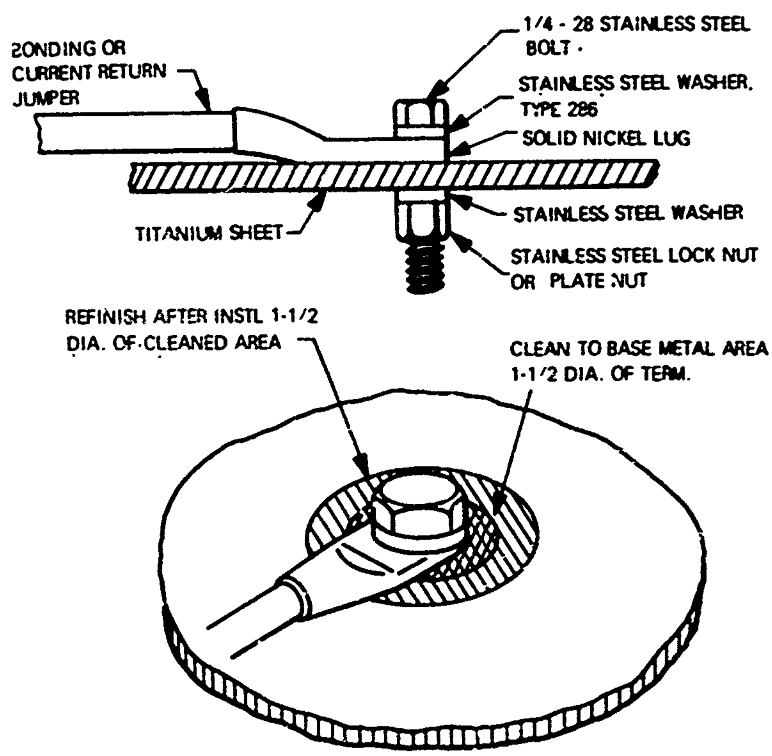
FIGURE 15 BONDING OF DETAILS WHICH ARE ISOLATED BY ADHESIVE.



NOTES:

1. These diagrams show typical use of fasteners for electrical bonding of adhesive isolated details.
2. Clean and refinish in accordance with 3.5.
3. A minimum of two fasteners shall be provided for bonding of any one honeycomb detail. The total number of fasteners and fastener spacing shall be shown on the installation drawing.

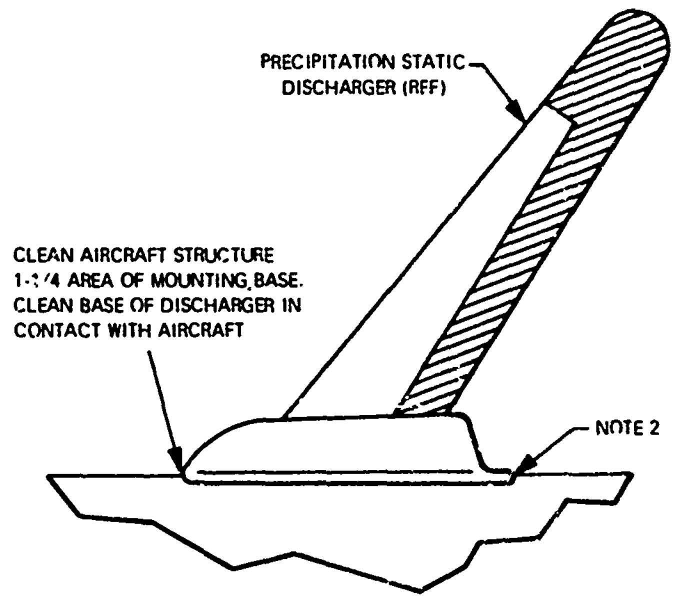
FIGURE 16 BONDING OF HONEYCOMB PARTS



NOTES:

1. Clean and refinish in accordance with 3.5
2. Nickel lug shall be flush mounted to bonding surface.
3. A bonding jumper shall be limited to a 60-amp Return.
4. Either heavy or light series washers shall be used, depending upon design detail on engineering drawing.

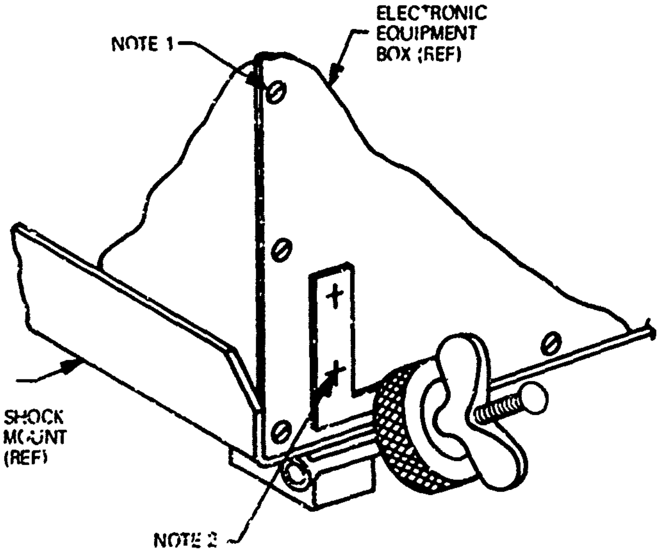
FIGURE 17 BONDING OF TITANIUM TO ALUMINUM



NOTES:

1. Install in accordance with manufacturer's procedure and the requirements of 3.4.2.
2. Mounting provisions to be specified on installation drawing.

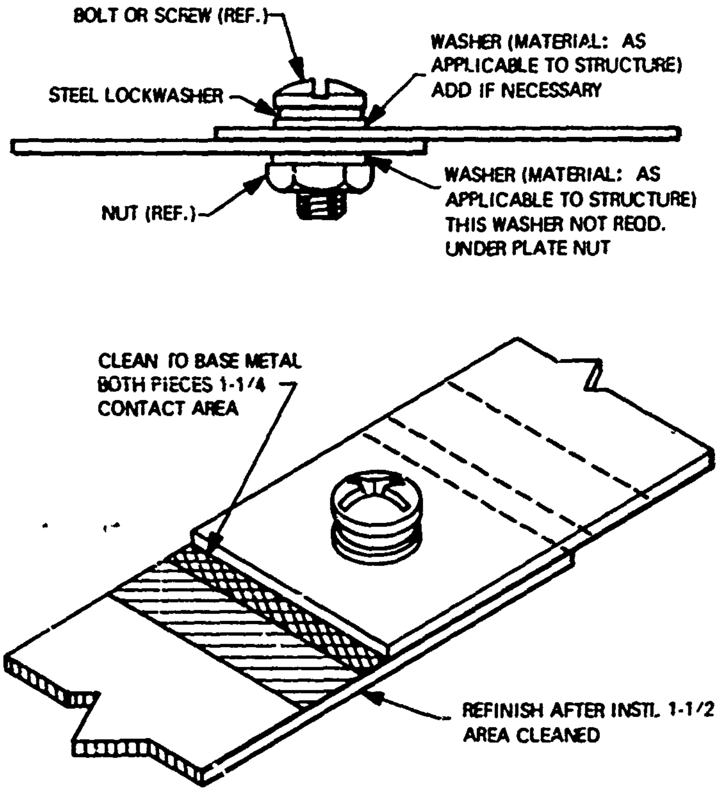
FIGURE 18 METHOD OF BONDING PRECIPITATION STATIC DISCHARGER ASSEMBLY TO EXTERIOR OF AIRCRAFT



NOTES:

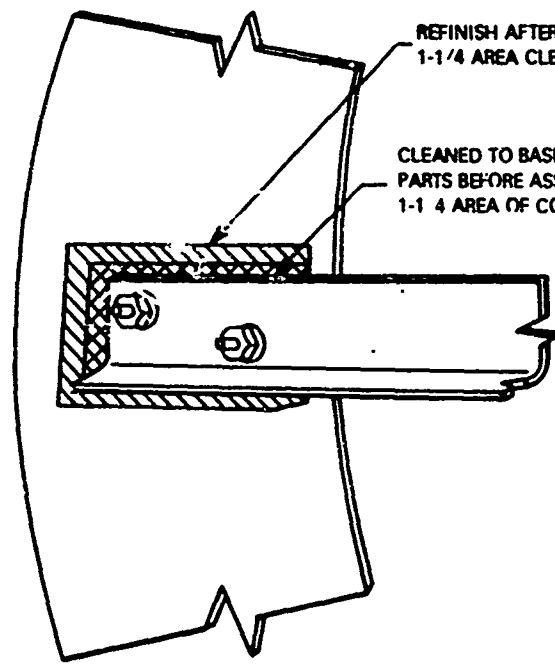
1. Front face of unit (and back, if separate) shall bond to case. Clean and protect in accordance with 3.5 if additional bonding is required.
2. If equipment case does not bond to shock mount, bond fitting to front face of electronic equipment box in accordance with 3.5.

FIGURE 19 METHOD OF BONDING ELECTRONIC EQUIPMENT BOX TO SHOCK MOUNT THROUGH FRONT ATTACHMENTS



NOTES:
1. Clean and refinish in accordance with 3.5.
2. Do not remove finish from under bolt head or nut.
3. Either heavy or light series washers shall be used depending upon design detail on engineering drawing.

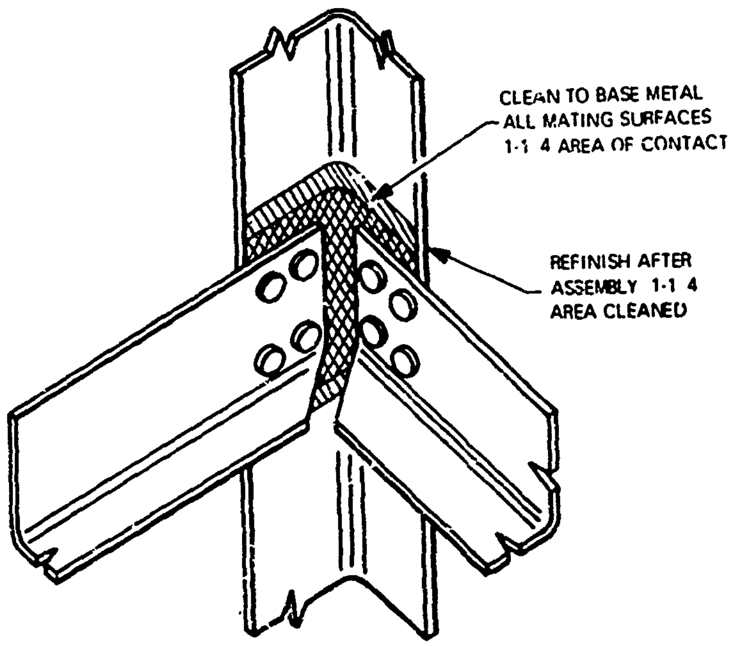
FIGURE 20 PREPARATION OF BONDING CONNECTION IN BOLTED STRUCTURAL JOINTS



NOTE:

1. Clean and refinish in accordance with 3.5.

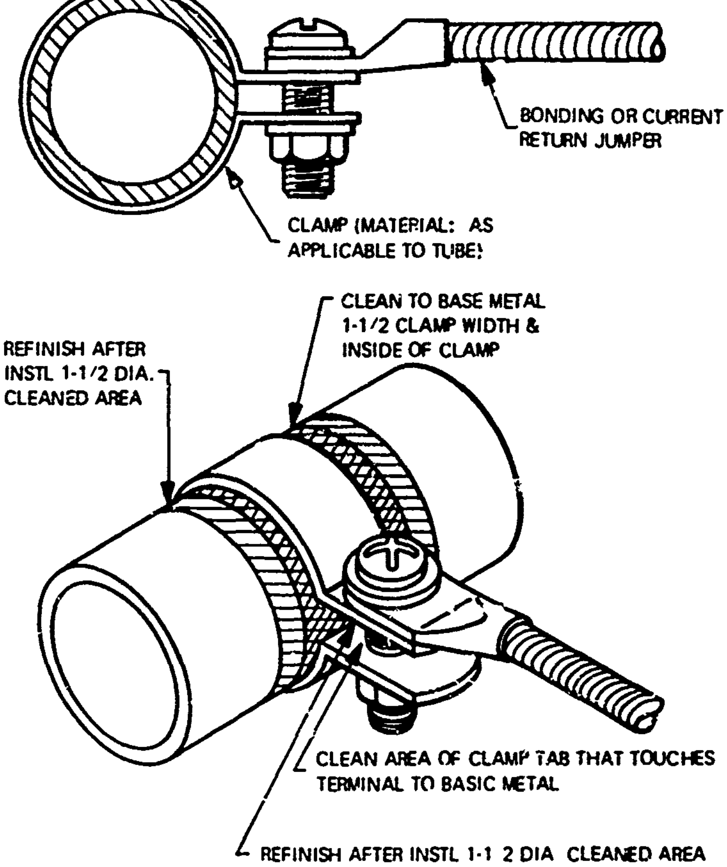
FIGURE 21 METHOD OF BONDING THROUGH BOLTED CONNECTION



NOTE:

1. Clean and refinish in accordance with 3.5.

FIGURE 22 METHOD OF BONDING BETWEEN STRUCTURAL PARTS IN AN ASSEMBLY.



NOTES:

1. Clean, and refinish in accordance with 3 5
2. Location of nut or head of bolt optional.
3. Either heavy or light series washers shall be used, depending upon design detail on engineering drawing.

FIGURE 23 CLAMP CONNECTION - JUMPER TO TUBE

EXHIBIT B

OF

APPENDIX A

TO

NAVAIR EMC EDUCATIONAL MANUAL

ELECTROMAGNETIC COMPATIBILITY ADVISORY BOARD (EMCAB) CHARTER

WANDOW AIRCRAFT ENGINEERING CORPORATION

PLYMOUTH, PA.

Report No. CHARTER-R-XX

Release Date 6 March 19XX

CHARTER FOR
XY-1A ELECTROMAGNETIC COMPATIBILITY
ADVISORY BOARD (EMCAB)

F. Smith Cognizant EMC Eng.	M. Blanc Deputy Eng. Mgr.
R. Brown EMC Department Head	W. Schwartz Support Mgr.
J. Dough Proj. Eng.	A. Jones Eng. Mgr.

CHARTER
ELECTROMAGNETIC COMPATIBILITY
ADVISORY BOARD

1.0 SCOPE

This charter delineates the responsibilities, objectives, membership, and operations of the XY-1A Electromagnetic Compatibility (EMC) Advisory Board hereinafter called EMCAB.

2.0 RESPONSIBILITIES

The EMCAB shall serve its Chairman in an advisory capacity to assist in the timely development, at minimum cost, of an electromagnetically compatible weapon system. EMCAB recommendations do not directly change any contractual obligations. Contractual changes may result from EMCAB recommendations. However, these contractual changes must be processed through established channels.

3.0 OBJECTIVES

The objectives are to identify potential EMC problems and recommend actions for their resolution, particularly with respect to problems encompassing joint Wandow/Navy responsibilities.

Potential EMC problems may result from previously unrecognized constraints or from recent program decisions.

The objectives are accomplished by:

- Regularly assembling a diverse group of skills
- Summarily reviewing the EMC program
- Examining potential EMC problem areas
- Defining specific problems
- Determining alternate solutions
- Selecting the best solution
- Recommending the course of action to solve problems

4.0 MEMBERSHIP

The EMCAB membership shall consist of personnel from the following organizations:

Wandow:

EMC Group Head	Chairman
Project EMC Group Leader	Vice Chairman
Project EMC Engineer	Secretary
Project EMC GSE Engineer	Member

Navy:

NAVAIR (EMC Project Engineer)	Lead Member (Vice Chairman)
NATC	Member
NADC	Member
NAVMISCEN/MUGU	Member
NAVPLANTREPO	Member
ECAC	Member

Subcontractors:

First Subcontractor, EMC Engineer — Member
Second Subcontractor, EMC Engineer — Member

Members may at their own discretion invite consultants or personnel from their staff or their subcontractors staff to aid in the discussion of an agenda item.

5. OPERATIONS

Meeting Dates

The first meeting of the EMCAB shall occur within 30 days after approval of this charter by NAVAIR. Subsequent meetings shall occur no more than 60 days apart. Special meetings may occur upon written request by any member with concurrence of the Chairman or Navy Vice Chairman.

Security

Each member shall establish the appropriate security classification in accordance with standard practice and routine.

Duties

Chairman – The primary duties of the Chairman are:

Chair the meeting or delegate the chair to a member of his staff or to the Wandow Vice Chairman

Approve agenda, meeting dates, recommendations, or other such issuances from the EMCAB

Assign presentations to appropriate organizations

Provide the interface between the EMCAB and other organizations

Present EMCAB summary report before adjournment of the meeting

Wandow Vice Chairman – The primary duties of the Wandow Vice Chairman are:

Serve as Chairman, as required

Plan, organize, and participate in the EMCAB meetings including the following:

determine the agenda, meeting place, and dates

notify members 15 days before meeting

provide for presentation of a summary status and review of the EMC program including problem definition and resolution, and future plans

provide an interface between the EMCAB and all project personnel, including Wandow sellers

arrange for other project personnel to attend EMCAB meetings

arrange for preparation and distribution of a report covering the minutes of the EMCAB meeting, the action items, and a tentative agenda for the next meeting. This shall be done within 30 days after the meeting.

Secretary – XY-1A EMC Engineer – The primary duties of the Secretary are:

Provide for general secretarial services including: recording of discussions, typing, agenda and report preparation, and luncheon arrangements

Read the minutes of the last meeting

Prepare the EMCAB summary report to be issued before meeting adjournment

Navy Vice Chairman – The primary duties of the Navy Vice Chairman are:

Provide the interface between the EMCAB and the Navy or other Department of Defense departments and government contractors

Make presentations on appropriate problems or topics

Arrange for other Navy or DoD personnel to attend or make presentations at EMCAB meetings

Represent the NAVAIR at the EMCAB

Approve the agenda, conference summary report, and the conference minutes and report

Members – The primary duties of the members are:

Provide the interface between the EMCAB and their organization

Make presentations on appropriate problems or topics

Arrange for personnel of their organization to attend or make presentations at EMCAB meetings

Provide recommendations to the Chairman

<u>Meeting Format – Generally the format of the meetings will be:</u>

Registration	Secretary
Call to order – announcements – introductions – welcome addresses (as required)	Chairman
Minutes of last meeting	Secretary
Old business	Chairman
Member reports (as required)	Members
New business	Chairman
Program summary, status and review	Window Vice Chairman
Problems, definition and resolution	
Plans	
Tentative agenda topics, place and dates of next meeting	Chairman
Summary report of conference	Chairman
Adjournment	Chairman

General Topics:
The topics for meetings will generally be keyed to the program. These shall include systems control plan, subsystem control plans, lightning, P-static, fuel ignition, RADHAZ, HERO, bonding, shielding, filtering, testing subsystems, testing systems, and testing aircraft.

Meeting Locations:
The location of EMCAB meetings shall normally be held at Wandow's Larksville XY-1A facilities. However, the Chairman or the Navy Vice Chairman may change the meeting site as appropriate for the agenda.

EXHIBIT C

OF

APPENDIX A

TO

NAVAIR EMC EDUCATIONAL MANUAL

AMENDMENTS TO MILITARY

SPECIFICATION MIL-E-6051D

1. SCOPE

1.1 This specification outlines the overall requirements for systems electromagnetic compatibility, including control of the system electromagnetic environment, lightning protection, static electricity, bonding, and grounding. It is applicable to complete systems, including all associated subsystems and equipments.

Delete and Substitute:
This specification delineates design requirements and test procedures necessary to weapon system compatibility of on-broad electrical-electronic subsystem and associated flight line support equipment. Compatibility between the weapon system and the external electromagnetic environment consisting of other C-E systems, shall be covered to the extent specified in the contract.

3.2.7 Spikes. For aircraft systems, spikes (transients) of less than 50 microseconds duration shall not exceed +50 percent nor -150 percent of the nominal DC line voltage, nor ±50 percent for AC power lines. Spikes lasting longer than 50 microseconds shall comply with the overvoltage curve in the applicable power quality specification. Requirements for other types of systems shall be included in the systems specification or in the EMC plan.

Delete and Substitute:
Spikes (transients) are exempted from the requirements specified herein if they cause no malfunctioning or unacceptable degradation of performance, are less than one second in duration, and during normal operation do not recur more often than once every three minutes. Selected equipment shall be tested to assure a safety margin for specified equipment having solid state devices connected to the aircraft AC and DC prime power bus, in accordance with 4.6

NOTE: Paragraph numbers referenced herein pertain to those in MIL-E-6051D.

4.4 Test Conditions

4.4.10 The EMC tests shall demonstrate the required compatibility when subsystems/equipments, excluding AGE (Aerospace Ground Equipment), trainers, and simulators in the weapon system test complex are collectively operated in all modes of operation. Transmitters and receivers shall be operated at those critical frequencies identified during system analysis and subsystem/equipment laboratory tests. Transmitter frequencies shall be chosen so that harmonics fall on frequencies such as receiver-tuned frequencies and intermediate. Multichannel transmitters and receivers shall be tested at a representative number of frequencies, usually not fewer than 20. Special frequencies used for command channels, distress messages, or other purposes shall be given special attention.

4.6 Safety Margins
When safety margins have been established and approved for subsystems/equipments, the inputs, outputs, or other test points shall be monitored continuously.

Delete and Substitute
The requirements of "no malfunctioning" shall be considered to have been met when the sum of all extraneous electromagnetic energy that may be introduced into the specified subsystem is the specified number of dB below that which would operate or actuate the subsystem or equipment. Detailed test methods,

instrumentation, monitoring point, and test procedures applicable to the functional use of the particular subsystem shall be outlined in the test plan specified herein. For example, the key test point in a guidance subsystem is the relay that actuates a hydraulic valve for control with a specified safety margin of 6 dB. In this case, an ammeter in the relay circuit indicating no more than half the current required for operation would be the no-malfunction limit. This shall be shown where possible and considered essential for selected subsystems, if excessive instrumentation, test time, and personnel will not be specified in the test plan that is subject to customer approval.

6.2.7 System

A weapon system is composed of airborne equipment, flight line support equipment, skills, and techniques which combine to form an instrument of combat having one air vehicle as its major operational element.

EXHIBIT D

OF

APPENDIX A

TO

NAVAIR EMC EDUCATIONAL MANUAL

EMC EXTERNAL ANALYSIS

COMPUTER PROGRAM

EXHIBIT D

EMC EXTERNAL ANALYSIS COMPUTER PROGRAM

1. INTRODUCTION

This exhibit describes the EMC external analysis computer program, which has been used successfully on the YN-2D and OV-22 programs. The program is limited to computing interferences coupled through paths external to the aircraft skin, and prints out interactions occurring via the antennas between the RF electronic equipments on-board the aircraft.

The data generated by the program is used for two purposes:

- To determine the conditions under which electromagnetic compatibility problems will occur so that the necessary corrective action can be taken
- To develop a comprehensive frequency selection plan for MIL-E-6051D test

2. PROGRAM OPERATION

This program is a technique used for automatic calculations of interactions in receivers caused by transmitted energy coupled through paths external to the aircraft skin. The program contains a mathematical model of avionics equipment, and in the absence of empirical data, calculates the important parameters required to develop the worst case emission and susceptibility signatures for the equipment. Consequently, all potential problems are uncovered.

Basically, the analysis can be thought of as placing a combination of transmitter and receiver pairs, including their transmission lines and antennas (Figure 6), at the disposal of the computer. The characteristics of each, in the form of a catalogue, are fed into the program that directs the computer to calculate the basic EMC equation:

$$\text{Problem Level}_{(dB)} = P^t + G_g^t + G_a^t + L + G_a^r + G_g^r + S$$

3. PROGRAM PARAMETERS

The specific program parameters are:

A. Determination of transmitter characteristics including:
   1) Transmitter harmonic frequency and amplitude
   2) Amplitude of spurious (non-harmonic) emissions
   3) Conversion of broadband energy to equivalent CW energy

B. Transmitter antenna, receiver antenna, and space loss considerations:
   1) Determination of free space distance between antennas
   2) Look angles (azimuth ϕ, elevation θ) relative to the established airframe coordinate system (station number, buttline number, and waterline number).
   3) Antenna gain referenced to a scale model pattern, as a function of azimuth ϕ, elevation θ
   4) Space loss
   5) Shading factor manually implemented into program
   6) Polarization loss

C. Receiver characteristics
   1) RF amplifier gain (or loss)
   2) Intermodulation frequency products of the mixer, if superheterodyne type receiver
   3) Sensitivity level of the receiver at the intermodulation frequencies, including crystal conversion losses

4. CONFIDENCE FACTORS

Special considerations have been built into the program to determine if the parameters of the equipment under consideration will yield a worst case prediction. This is accomplished by using both empirical data fed into the program and by incorporation of a simple statistical analysis into the computer computations of these same parameters, and comparing the results.

To create worst case conditions, the calculated values of the parameters are adjusted to assure a high confidence level of the interactions predicted or not predicted.

1) All transmitters are assumed capable of output power four times the published guaranteed minimum value.
2) All receivers are assumed capable of receiving signals at least one half the published guaranteed minimum value.
3) When specified design goals exceed the values indicated in 1) and 2) above, a "modifying factor" has been provided to change the statistical base by individual equipment.
4) Specific frequencies involved in coincidence match, are assumed to be capable of varying plus or minus one half of the receiver's IF bandwidth.

Use of the above principles brings the confidence level that all potential interactions have been predicted to nearly 90 percent.

5. PROBLEM SUMMATION

At the conclusion of a computer run, which has compared a number of transmitters (M) with a number of receivers (N), a summary matrix is printed out for each section of the program. This yields a "M x N" matrix with the worst problem predicted for each pair of transmitter-receivers. The matrix also contains information relating the basic parameters used to calculate the problem level such as receiver desensitization problems and systems that are time-multiplexed or blanked.

6. PROGRAM VERIFICATION

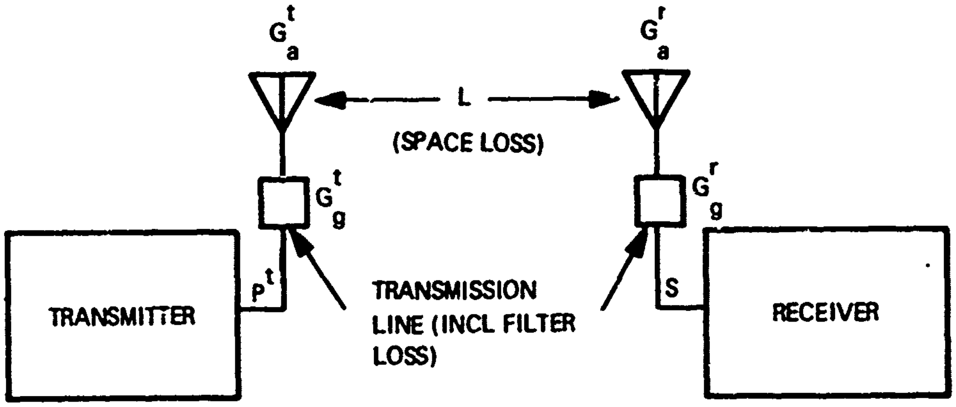
The usefulness of this computer program was verified by a comparison of the empirical MIL-E-6051 test data contained in Wandow Report VA-985872, "Electromagnetic Interference Test on Z-7U Bu No. AB87Y2 Shop No. 6" with predictions from the computer print-out for a simulated problem Figure 7 is a sample of the data summary for the two units whose operation was simulated, the UHF Comm (RT-000) and the TACAN (RT-000) receiver-transmitters. The antennas for both of these units are on the underside of the fuselage of the Z-7U aircraft and are about 15 feet apart. Both are of the blade type.

The matrix formulated by these equipments was expanded to account for the variance on receiver parameters over different frequency ranges of operation and to account for radiation of internal oscillators.

The predictions obtained from the computer print-out were compared with the measured values published in the above referenced report. The result of this comparison is summarized in Figure 8.

The maximum difference between actual measured and predicted values obtained by the EMC external analysis technique was only 8 dB, a response obtained when the UHF Comm (RT-000) was tuned to one third the TACAN frequency and caused by the TACAN second local oscillator (RT-000).

C sidering the many assumptions made with respect to certain parameters such as front-end rejection and antenna isolation, a difference of 8 dB is considered very good correlation. The accuracy of the predicted analysis technique relative to measured data is considered to be in the range of ±10 dB.



P_t : TRANSMITTER OUTPUT POWER IN DBM

G_g^t : TRANSMITTER LINE LOSSES OR GAINS IN ± DB

G_a^t : TRANSMITTER ANTENNA LOSSES OR GAINS IN ± DB

L : SPACE LOSS AS A FUNCTION OF DISTANCE, FREQUENCY AND AIRCRAFT SHADOWING

G_a^r : RECEIVER ANTENNA LOSSES OR GAINS IN ± DB

G_g^r : RECEIVER LINE LOSSES OR GAINS IN ± DB

S : SUSCEPTIBILITY OR SENSITIVITY LEVEL IN DBM

FIGURE 6 BASIC PREDICTION MODEL

Equipment Name	Computer Designation	Operating Characteristics		
		Frequency Range, MHz	F_{if}	Power Output dbm
TACAN, Xmtr	RT–541	925 to 1750		+30
TACAN, first LO	RT–541A	925 to 1750		-15
TACAN, second LO	RT–541B	275 to 285		-70
UHF, Comm	RT–542	220 – 399.9		+27
TACAN, Ch 1 to 62	RT–541L	851 to 1095	-100	-92
TACAN, Ch 63 to 125	TR–541H	1262 to 1719	+100	-91
UHF, Comm.	RT–542A	330 to 490	+ 30	-78
UHF, Comm.	TR–542B	336 to 370	+ 31	-78
UHF, Comm.	RT–542C	317 to 371	+314	-78
UHF, Comm.	TR–542D	917 to 1017	+ 34	-78
UHF, Comm.	RT–542E	125 to 126	+ 34.8	-78
UHF, Comm.	RT–542F	126 to 127	+ 35	-78
UHF, Comm.	RT–542G	230 to 400	+39.7	-78

FIGURE 7 MAJOR EQUIPMENT PARAMETERS

XMTR / RCVR	RT-541		RT-541A		RT-541B		RT-542	
	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.	PRED.	MEAS.
RT-541L	0	0	0	0	0	0	65 9X70R	65
RT-541H	0	0	0	0	0	0	36	36
RT-542	14 8X312	0	0	0	92 1X10R	60	0	0

NOTE 1. Symbol Code
0 indicates system is blanked
RT-541 Normal transmission
RT-541A First LO radiation
RT-541B Second LO radiation
RT-541L Received channels 10 to 620
RT-541H Received channels 92 to 16

NOTE 2. Measured values taken from Wandow Report VA 985870

FIGURE 8 INTERMODULATION/HARMONIC PRODUCTS

EXHIBIT E

OF

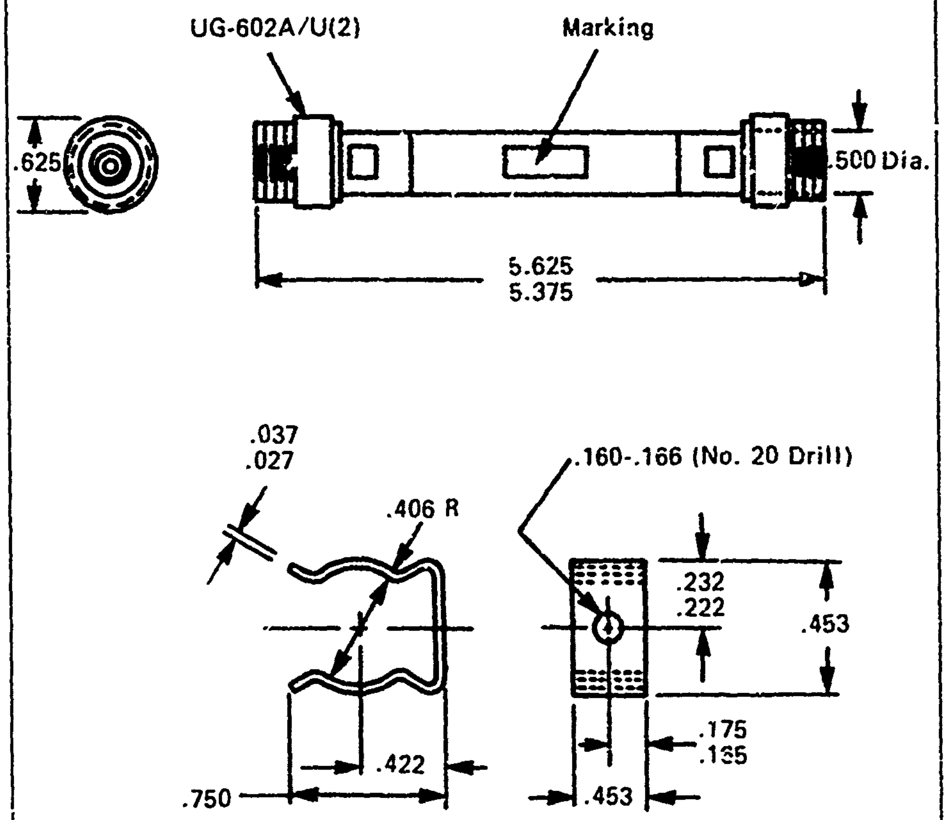
APPENDIX A

TO

NAVAIR EMC EDUCATIONAL MANUAL

BANDPASS FILTER SPECIFICATION

E-1



Mounting Clip (2 Supplied)

APPROVED NUMBER	I-TEL PART NUMBER REF	APPROX WEIGHT LBS
WA582AW	FBT/2-220/225-07-1A/1A	0.25

SUPERSEDES AND REPLACES AUTHORIZED INTERIM DRAWING SAME NUMBER

EXAMPLE OF BILL OF MATERIALS CALLOUT — SPECIFICATION CONTROL DRAWING

WA582AW	FILTER	WANDOW STD			
PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	GOVT SPEC	COML SPEC	STOCK SIZE (EA)

FILTER

ELEC BAND PASS, 2200 TO 2300 MHz. SERIES "N" CONN

SELECTED CATALOG PART

WANDOW STANDARD

CODE IDENT NO. 26512

WA582AW

SHEET 1 OF 3

FIGURE 9 FILTER

1

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REQUIREMENTS

1. GENERAL:
   - 1.1 PARTS SHALL MEET THE REQUIREMENTS SPECIFIED HEREIN
   - 1.2 FOR DESIGN FEATURE PURPOSES, THIS STANDARD TAKES PRECEDENCE OVER THE DOCUMENTS REFERENCED HEREIN WHICH SHALL BE OF THE ISSUE IN EFFECT ON DATE OF INVITATIONS FOR BID
   - 1.3 THE VENDOR(S) LISTED ARE THE ONLY APPROVED SOURCES FOR ARTICLES SHOWN HEREIN. ANY CHANGE MADE BY VENDOR(S) WITHOUT PRIOR WANDOW APPROVAL MAY RESULT IN REJECTION OF PARTS AND IN VENDOR DISQUALIFICATION
2. MECHANICAL
   - 2.1 MATERIAL – CASE – ALUMINUM ALLOY
MOUNTING CLIP – BERYLLIUM COPPER
   - 2.2 FINISH – CASE – GOLD HAMMERTONE BAKED ENAMEL
MOUNTING CLIP – NICKEL PLATE
   - 2.3 CONNECTOR – TWO (2) SERIES "N" JACKS
3. ELECTRICAL
   - 3.1 PASSBAND – 2200 to 2300 MHZ
   - 3.2 REJECTION –
     - 3.2.1 -60 DECIBELS MINIMUM AT 1000 MHz
     - 3.2.2 -60 DECIBELS MINIMUM FROM 4000 MHZ THRU 6500 MHZ AND 8000 MHZ THRU 12,000 MHZ
   - 3.3 VSWR – NOT TO EXCEED 1.3:1 OVER THE FREQUENCY RANGE OF 2200 TO 2300 MHZ
   - 3.4 INSERTION LOSS – 0.5 DECIBELS MAXIMUM OVER THE FREQUENCY RANGE OF 2200 TO 2300 MHZ WHEN MEASURED IN A 50 OHM SYSTEM
   - 3.5 AVERAGE POWER CAPABILITY – 5 WATTS MAXIMUM
   - 3.6 IMPEDANCE – 50 OHMS NOMINAL
   - 3.7 DIELECTRIC WITHSTANDING VOLTAGE – 100 VOLTS AC BETWEEN CENTER CONNECTOR CONTACTS AND CASE PER MIL-STD-202 METHOD 301

SUPERSEDES AND REPLACES AUTHORIZED INTERIM DRAWING SAME NUMBER

EXAMPLE OF BILL OF MATERIALS CALLOUT — SPECIFICATION CONTROL DRAWING

WA582AW	FILTER	WANDOW STD			
PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	GOVT SPEC	COML SPEC	STOCK SIZE (CAT

FILTER

ELEC. BAND PASS, 2200 TO 2300 MHz. SERIES "N" CONN

SELECTED CATALOG PART

WANDOW STANDARD

CODE IDENT NO. 26552

WA582AW

SHEET 2 OF 3

FIGURE 9 FILTER (CONT'D)

4. ENVIRONMENTAL
   4.1 TEMPERATURE RANGE –
      4.1.1 OPERATING – -55°C TO +125°C (-67°F TO +256°F)
      4.1.2 STORAGE – -65°C TO +135°C (-84°F TO +274°F)
   4.2 THERMAL SHOCK – PER MIL-STD-202 METHOD 107A, CONDITION B
   4.3 ALTITUDE – 70,000 FEET
   4.4 SALT SPRAY – PER MIL-STD-202, METHOD 101 CONDITION B
   4.5 MOISTURE RESISTANCE – PER MIL-STD-202 METHOD 106
5. PHYSICAL
   5.1 SHOCK – 50 G'S. 11 MILLISECONDS PER MIL-STD-202 METHOD 202A
   5.2 VIBRATION – 5-2000 CYCLES: 20 G'S PEAK PER MIL-STD-202 METHOD 204A. CONDITION D
   5.3 ACCELERATION – 10 G'S IN EACH OF THREE MUTUALLY PERPENDICULAR DIRECTIONS PER MIL-STD-207 METHOD 212. CONDITION B
6. DIMENSIONS IN INCHES. TOLERANCES: UNLESS OTHERWISE SPECIFIED (.016)
7. MARKING
   7.1 PARTS SHALL BE LEGIBLY AND PERMANENTLY MARKED WITH THE MANUFACTURER'S NAME OR TRADEMARK AND PART NUMBER
   7.2 PACKAGES SHALL BE LEGIBLY MARKED WITH THE WANDOW APPROVED NUMBER

EXAMPLE OF APPROVED NUMBER

1. WA582AW – FILTER, ELECTRICAL, BAND PASS, 2200 TO 2300 MHZ, TWO (2) SERIES "N" CONNECTORS

PROCUREMENT

1. DEFEL INCORPORATED
   KINGSTON, PENNSYLVANIA (FSCM 21377)

SUPERSEDES AND REPLACES AUTHORIZED INTERIM DRAWING SAME NUMBER

EXAMPLE OF BILL OF MATERIALS CALLOUT — SPECIFICATION CONTROL DRAWING

WA582AW	FILTER	WANDOW STD			
PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL	GOVT SPEC	COML SPEC	STOCK SIZE EA.

FILTER	CODE IDENT NO. 26512
ELEC. BAND PASS. 2200 TO 2300 MHz. SERIES "N" CONN	WA582AW
SELECTED CATALOG PART	
WANDOW STANDARD	SHEET 3 OF 3

FIGURE 9 FILTER (CONT'D)

EXHIBIT F

OF

APPENDIX A

TO

NAVAIR EMC EDUCATIONAL MANUAL

BLANKING MATRIX AND LOGIC

Preceding page blank

TRANSMITTERS

RECEIVERS	TACAN ARN-0	IFF XPDR APX-0	IFF INTR APX-0A	RADAR AWG-0	RAD ALT APN-00	ALQ-00A	ALQ-00	BEACON APN-000		
TACAN ARN-0		X	X							
IFF XPDR APX-0	X		X							
IFF INTR APX-0A	X	X								
RADAR AWG-0						X				
RAD ALT APN-00										
ALQ-00A				(1)				(3)		
ALQ-00					X					
APR-00				X		X	X			
BEACON APN-000						(3)				

X Indicated Blanking Requirement (co-channel or Adjacent - Channel Interference)

(1) Used for MAX PWR MODE ONLY

(2) Internal Non Sychronous Receiver Blanking

(3) Mission Does Not Require Simultaneous Operation of these Equipments.

FIGURE 10 BLANKING MATRIX

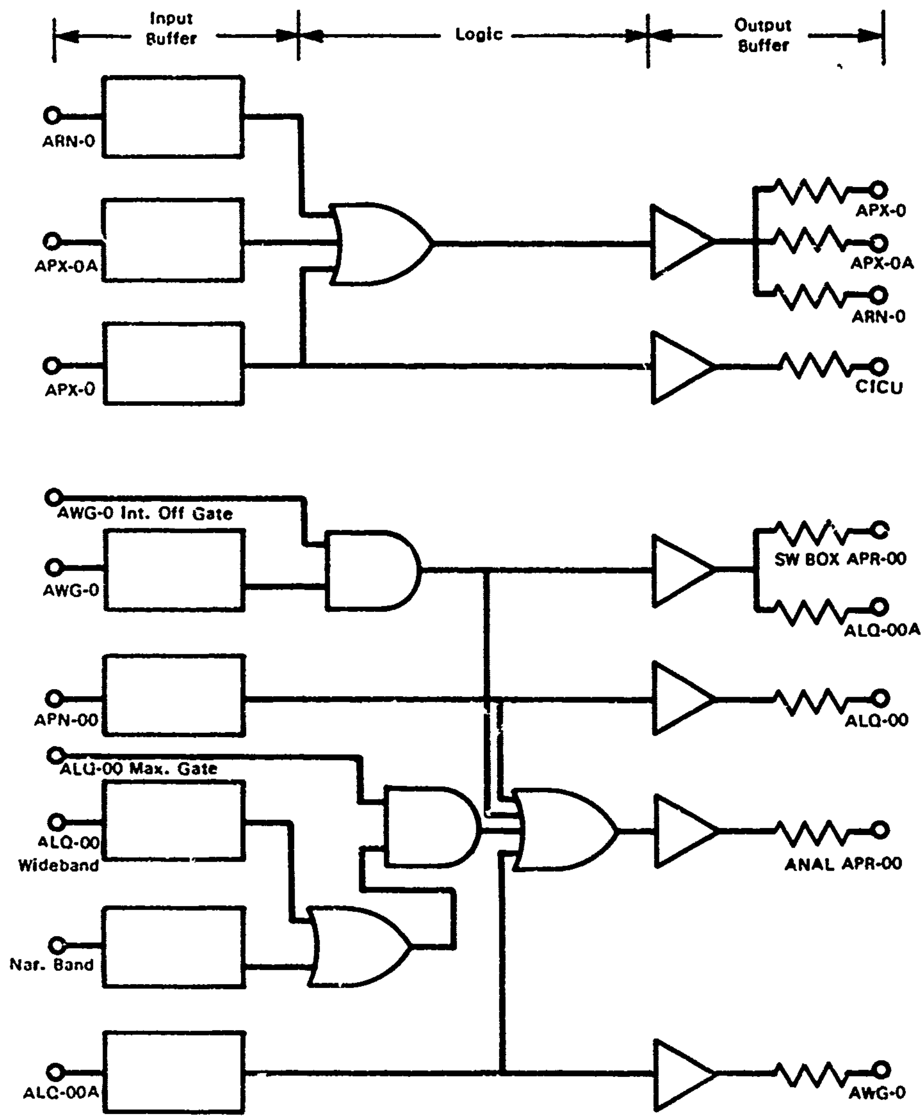


FIGURE 11 - BLANKING LOGIC

EXHIBIT G

OF

APPENDIX A

TO

NAVAIR EMC EDUCATIONAL MANUAL

GENERAL SUBSYSTEM EMI REQUIREMENTS

Subsystem EMI requirements shall be as follows:

1.0 Test Requirements and Limits of Specifications MIL-STD-461 and MIL-STD-462

Equipment shall comply with the limits of paragraph 6 of MIL-STD-461 as measured using the procedures specified in paragraph 5 of MIL-STD-462.

2.0 Transient Conducted Interference Susceptibility

The test procedure of MIL-STD-462, Method CS06 shall be modified to the extent described herein. Pulses of 50 volt amplitude, both positive and negative polarity, shall be injected into each AC and DC power lead at a repetition rate of 10 pps minimum for that time necessary to determine if the test sample is susceptible. The characteristics of the transient pulse, as measured by an oscilloscope across the input terminal of the test sample while the test sample is operating, shall follow the typical waveshape specified in Figure 12. Either series or parallel injection shall be used as shown in Figure 13. Line stabilization networks and 10 mFd capacitors shall be removed during these tests.

3.0 Transient Radiated Interference Susceptibility

The tests shall be performed in accordance with Figure 14. The relay used shall be Type MS25271 or an equivalent. No suppression shall be applied to the relay. The relay circuit shall be unshielded wire tightly coupled (taped) to and in parallel with the equipment power leads and signal leads, and tightly looped about the units of the equipment comprising the test sample. The test shall be performed with the double-pole double-throw switch in position A first and then in position B. The test shall be run long enough to determine if the test sample is susceptible.

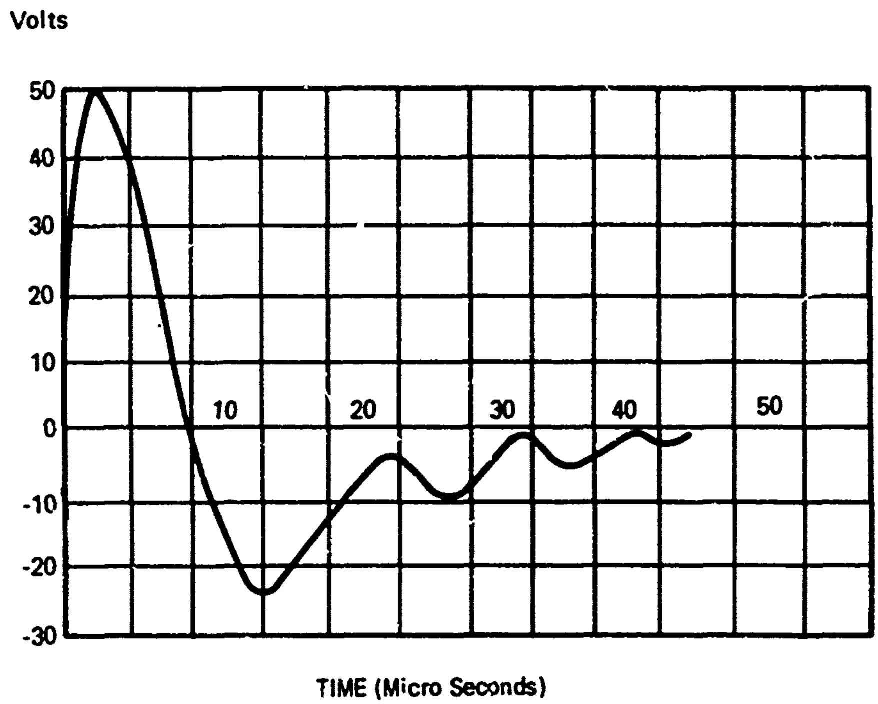
4.0 Induction Field Interference Susceptibility

4.1 Cable Bundle Test and Requirements

The test procedure of MIL-STD-462, Method RS02 shall be modified to the extent described herein: Tape two insulated, unshielded wires to each cable bundle of the test sample, 90 degrees apart. The current-carrying wires shall be run the entire length of the bundle under test, and as close as possible to each end connector. Apply 20 amperes of AC current at a frequency of 400 Hz to each wire, one at a time. See Figure 15, for the test setup. All cable bundles shall be no fewer than 2 inches above ground plane. AC power leads may be exempt from this test. The test shall be run for that time necessary to determine if the test sample is susceptible.

5.0 Radiated Field Interference Susceptibility

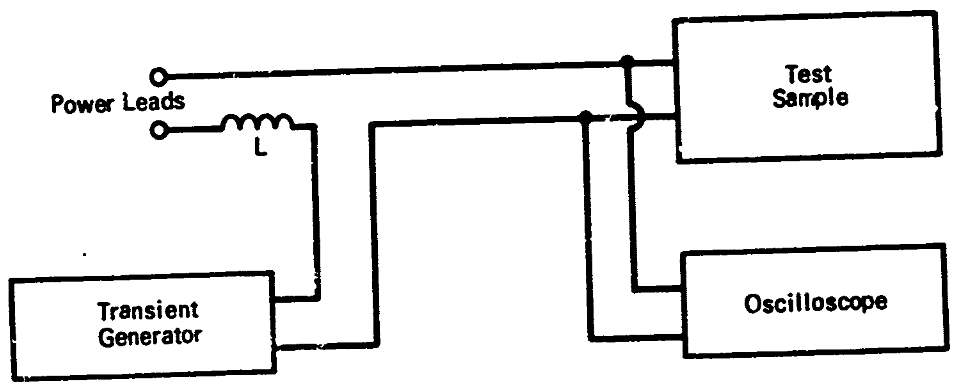
The test procedure of MIL-STD-462, Method RS03 shall be modified to the extent described herein. The cables and units comprising the test sample shall be subjected to a 1.0 volt per meter field in the frequency range of 0.155 MHz to 20 GHz. The modulation of the RF signal shall be those rates and indices to which the test sample is most susceptible.



Typical Injected Spike at Input
To Test Sample

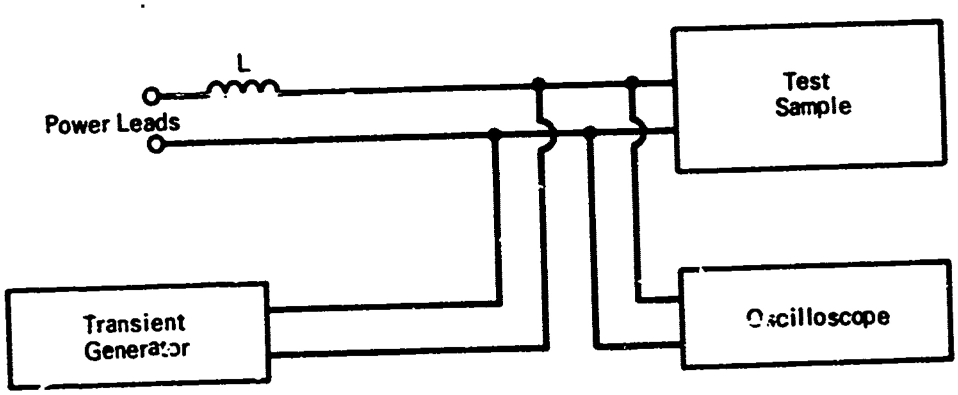
FIGURE 12 PULSE CHARACTERISTICS TRANSIENT CONDUCTED INTERFERENCE SUSCEPTIBILITY

a. Series Injection Test Setup



L = 20 Microhenries

b. Parallel Injection Test Setup



L = 20 Microhenries

FIGURE 13 TRANSIENT CONDUCTED INTERFERENCE SUSCEPTIBILITY

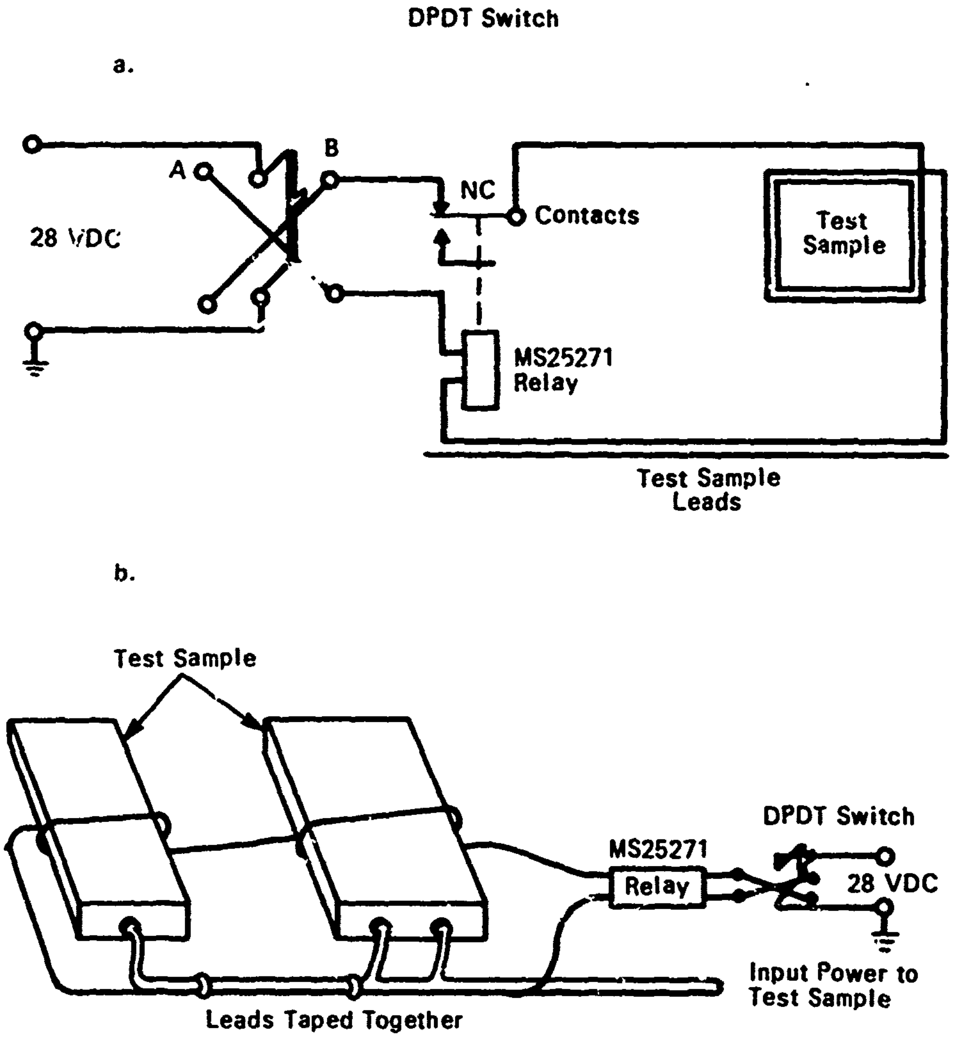


FIGURE 14 TRANSIENT RADIATED INTERFERENCE SUSCEPTIBILITY

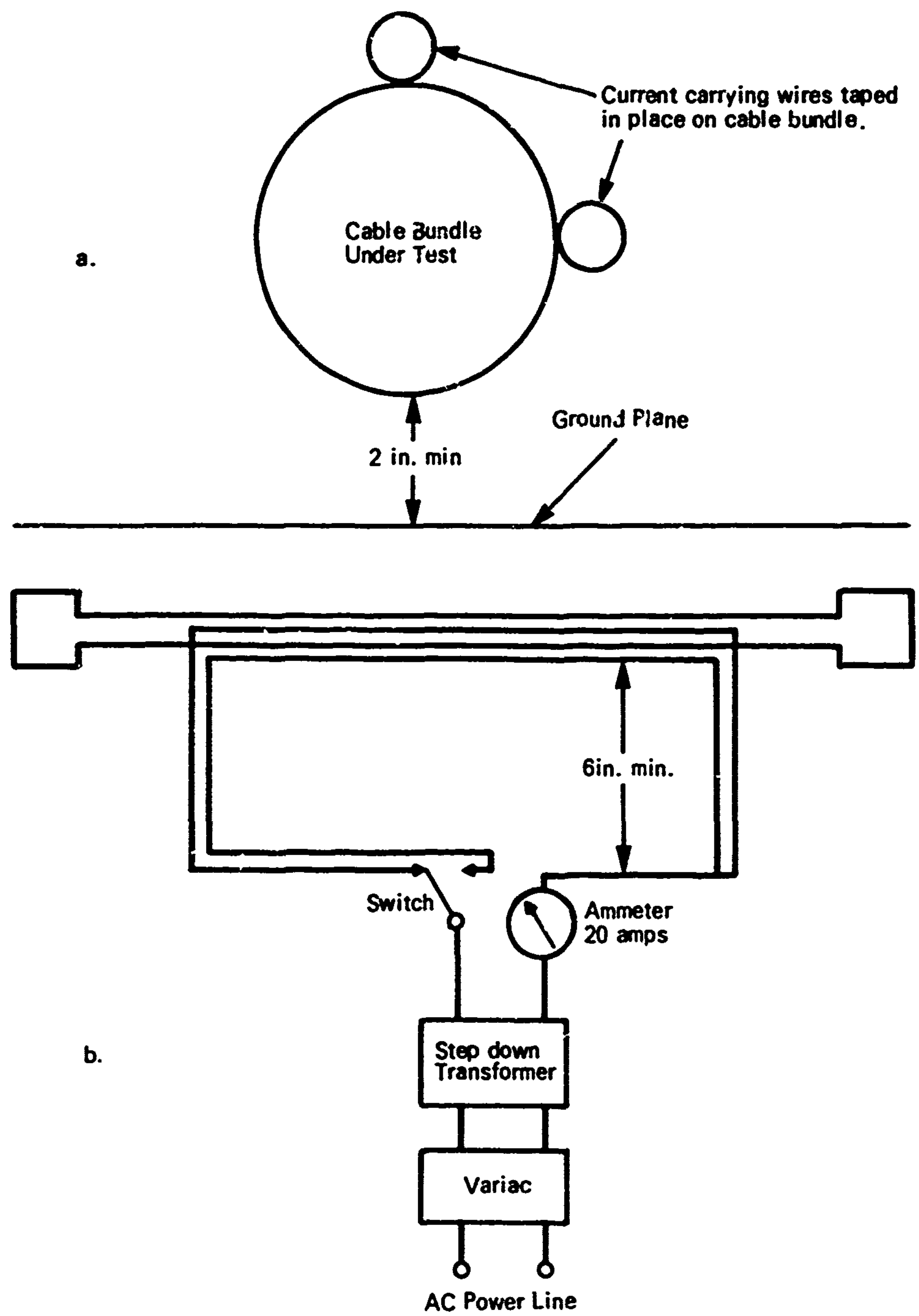


FIGURE 15 CABLE BUNDLE TEST INDUCTION FIELD INTERFERENCE SUSCEPTIBILITY

EXHIBIT H

OF

APPENDIX A

TO

NAVAIR EMC EDUCATIONAL MANUAL

RECEIVER-TRANSMITTER SUBSYSTEM
EMI REQUIREMENTS

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To assure compatibility of the out-of-band characteristics of receivers and transmitters, limits have been established for receiver response or rejection and transmitter spurious output. Each type of equipment has a set of limits based on acceptable signal to interference levels. Receivers are exempt from these limits at the desired tuned frequency and necessary sidebands. Transmitters are exempt at the fundamental operating frequency and necessary sidebands.

Equipment →	UHF		IFF		TACAN		APR-00	AUX. RCVR
FREQ-MHZ	RCVR REJ.	XMTR MAX.	RCVR REJ.	XMTR MAX.	RCVR REJ.	XMTR MAX.	RCVR REJ.	RCVR REJ.
200-400	+2	-35	-10	-80	0	-50	-10	+12
400-900	+15	-20	-20	-60	-10	-50	-20	+25
900-1500	+5	-30	-20	-70	-10	-40	-10	+15
1500-3000	+5	-10	+5	-20	+15	-10	+15	+5
3000-7000	-5	-10	-5	-10	-5	-10	-5	-5
7000-11000	-10	-10	-20	-30	-30	-20	-20	-10
11000-16000	-20	-10	-30	-50	-40	-20	-30	-30

SIGNAL LEVELS ARE PEAK dBm

FIGURE 16 LIMITS FOR RECEIVER SUPURIOUS RESPONSE AND TRANSMITTER SPURIOUS OUTPUT CHARACTERISTICS

1

EXHIBIT I

OF

APPENDIX A

TO

NAVAIR EMC EDUCATIONAL MANUAL

FACILITIES

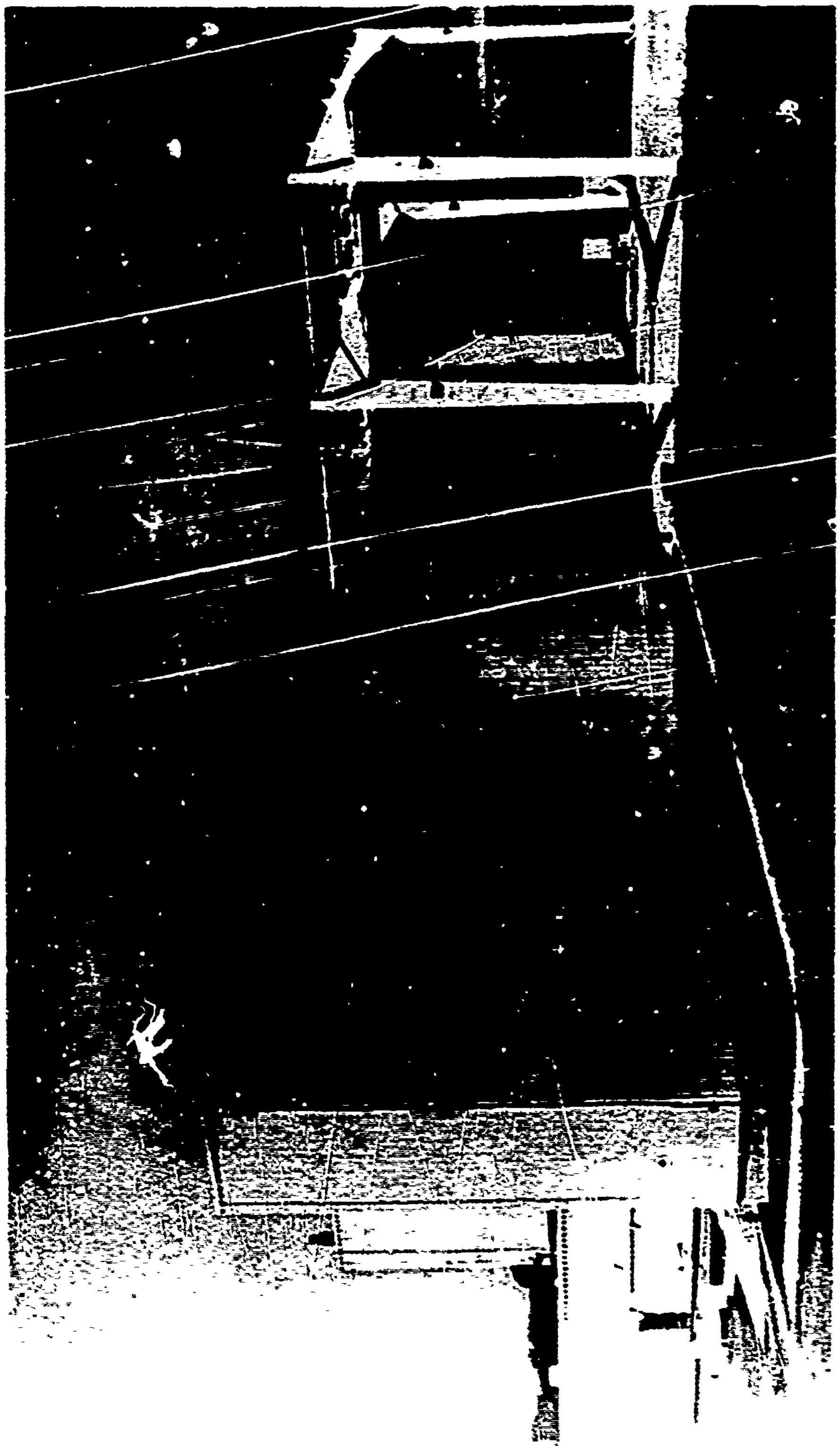


FIGURE 17 ANECHOIC CHAMBER BUILDING, EXTERIOR

1

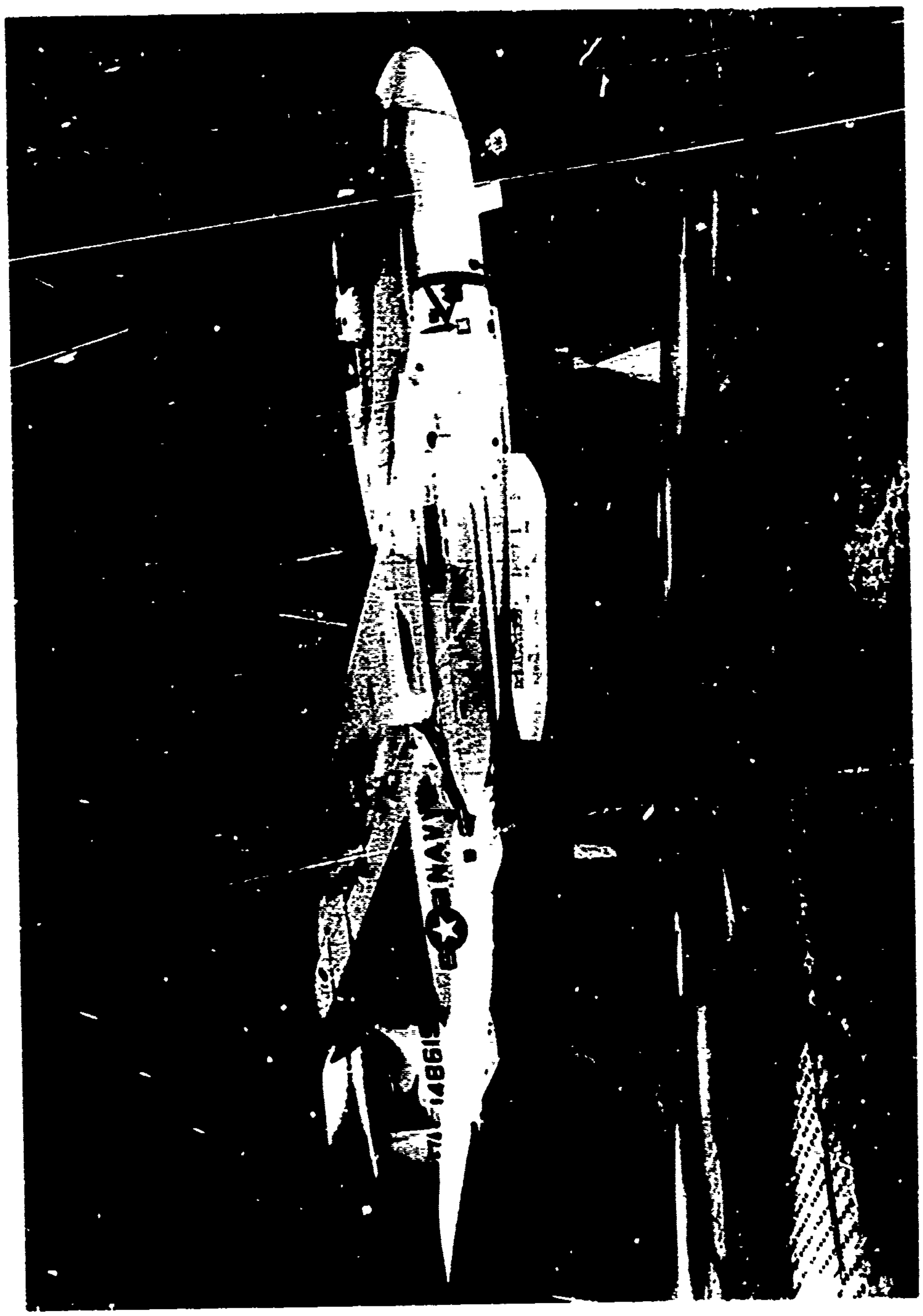


FIGURE 17A ANECHOIC CHAMBER BUILDING INTERIOR

2

FIGURE 18 XY 1A EMC TEST EQUIPMENT

Description	Manuf.	Model	Freq.	Power	Requirement Freq.	Requirement Power	Notes
Power Sweep Generator	Solar	6550-1	15-150,000 Hz	100W	50-100,000 Hz	50W	
Isolation Tran	Solar	6220-1A	50 Hz-250 KHz	50A	50 Hz-15 KHz	20A	
General Sweeper	HP	8610	100 KHz - 110 MHz	+20 dbm	100 KHz - 110 MHz	+20 dbm	
Generator	HP	608C	10 MHz 480 MHz	+7 dbm	110 MHz 480 MHz	+7 dbm	
TWT Amplifier	Microwave Associates	MA-2721	.5-1 GHz	2W	.5-1 GHz	1W	
Power Amplifier	HP	230A	10-500 MHz	4.5W	25-500 MHz	1W	
Microwave Amplifier	HP	489A	1-2 GHz	1W	1-2 GHz	+20 dbm	
Microwave Amplifier	HP	491C	2-4 GHz	1W	2-4 GHz	+20 dbm	
Microwave Amplifier	HP	493A	4-8 GHz	1W	4-8 GHz	+20 dbm	
Microwave Amplifier	HP	495A	7-124 GHz	1W	7-12.4 GHz	+20 dbm	
Transient Generator	Solar	6254-5	3 us	300V	3 us	100V	
Variac	GR	M20	400 Hz	20A	400 Hz	20A	
Relay	Guardian	MS25271D1					2 Reqd.
AC Ammeter	Weston	433	500 Hz	50A	400 Hz	20A	
Pulse Generator	EH	132A	100 MS - 10 MS	50V	100 MS - 10 MS	50V	

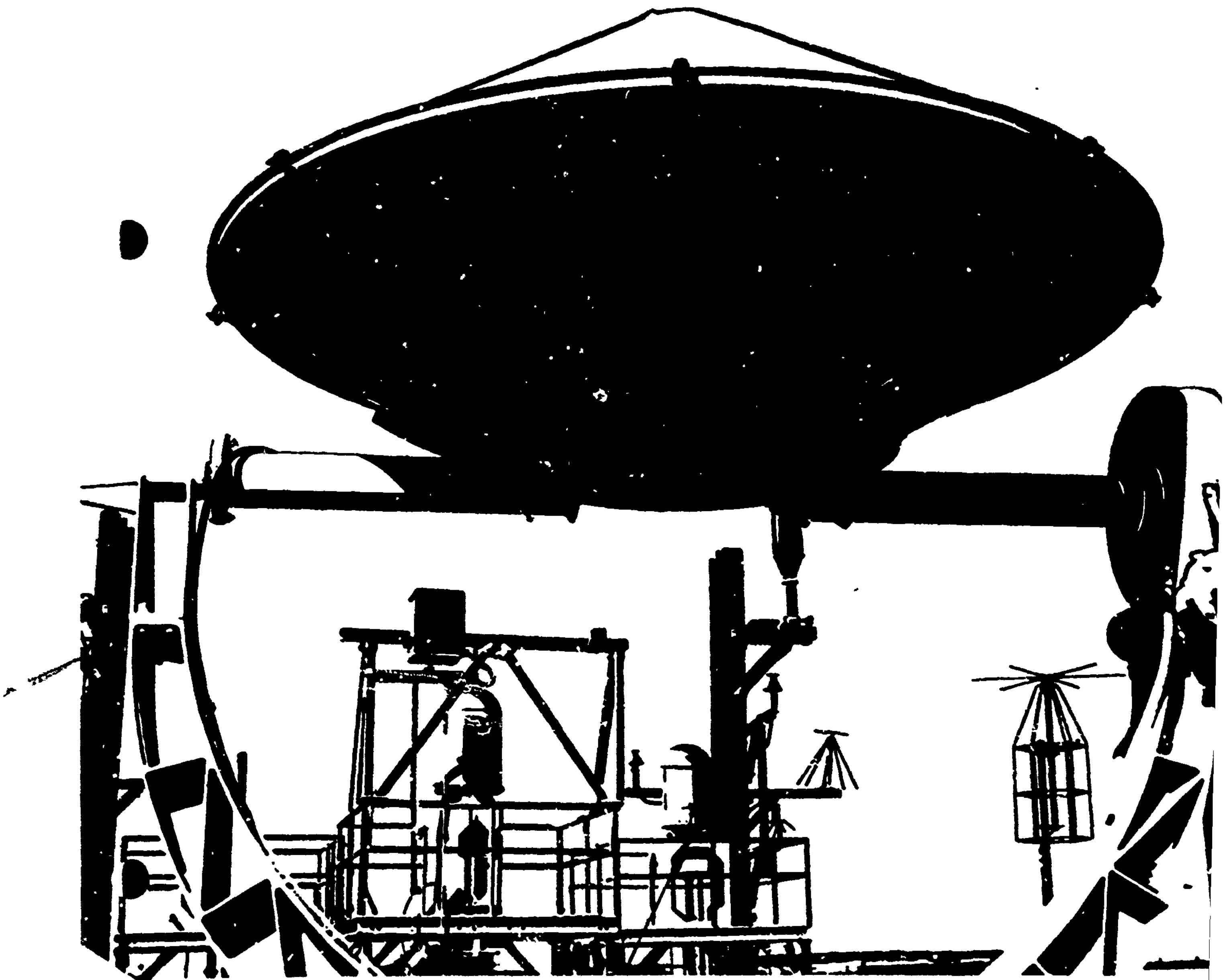
NAVAIR 5335

NAVAL AIR SYSTEMS COMMAND

ELECTROMAGNETIC COMPATIBILITY MANUAL

APPENDIX B

SAMPLE EMI CONTROL PLAN FOR AN EQUIPMENT OR SUBSYSTEM



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NAVAIR EMC MANUAL

APPENDIX B

SAMPLE EMI CONTROL PLAN FOR AN EQUIPMENT OR SUBSYSTEM

PREFACE

This EMI Control Plan is typical of the type prepared by a contractor who is developing an electronic equipment or subsystem under contract with the Navy or other DoD component. It is the type of Control Plan that must be provided when a contract calls for compliance with the requirements of MIL-STD-461, Electromagnetic Interference Characteristics Requirements for Equipment. The content of any actual Control Plan should be similar to this sample, but should conform to the content requirements of the issue of MIL-STD-461 according to the applicable contract, and should be adapted to the particular equipment or subsystem procurement. The Control Plan for procurement of a subsystem containing a number of equipments will naturally be more complex than one for procurement of a single equipment. The example given herein is of the type required for a subsystem procurement.

In general, the Control Plan should describe:

1. The contractor's EMC organization, including responsibilities and lines of authority
2. The design approaches to be used to achieve EMC, including both mechanical and electrical/electronic design
3. The dates for design reviews and progress milestones
4. Analysis techniques to be used for predicting and eliminating interference
5. The intended testing program for validating predictions and demonstrating compliance with the requirements of MIL-STD-461, including type of tests, test equipment, test facilities, test personnel, and testing schedules
6. How EMC requirements will be imposed on all subcontractors and vendors

The intent of this sample EMI Control Plan is to indicate the types and quantity of information to be included in such a plan, not to indicate the specific EMC organization, analysis methods, electronic/mechanical design, wiring categories, cable routing, and other features of an EMC program. These features should be tailored to fit the procurement, the contractor's normal mode of operation, the current state of the EMC art, and conform to good engineering design in general. The prime criterion is that the content should describe in detail the contractor's entire electromagnetic compatibility program. This program should be adequate to assure compliance with the requirements of MIL-STD-461 and any other EMC requirements imposed by the contract.

Approval of the Control Plan and compliance with it does not relieve the contractor of the responsibility of meeting the applicable EMC requirements of MIL-STD-461 and other EMC requirements as specified in the contract. Any deviations from these requirements will require the submission of a formal request for deviation, using established procedures. Such deviations may be required to adapt the requirements to the particular equipment or subsystem being procured. These deviations should be described in the Control Plan, but only those deviations that are officially granted will be contractually binding. The formal procedures for requesting and granting deviations are described in NAVAIR Instructions 4355.9.

DURON CORPORATION

Sterling, Illinois

NUMBER: RP/88-3

DATE: 15 March 1970

ELECTROMAGNETIC INTERFERENCE

CONTROL PLAN

FOR

DATA LINK SUBSYSTEM

PREPARED

BY

DURON CORPORATION

FOR

SOUTHWIC AIRCRAFT CORPORATION

Prepared By

Project Engineer

Reliability

Technical Publications

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1.0 SCOPE. The purpose of this document is to define the specific EMC organization of the Duron Corporation, test methods and design techniques that will be used throughout all phases of the data link design and development program. The intent is to yield a final subsystem capable of meeting the requirements of specification MIL-STD-461A using the limits specified therein or the increased susceptibility fields as defined in the detailed specifications for the various subsystem elements. The operational performance of each element will not be degraded nor malfunctioned when all the elements in the data link subsystem are operated in all required modes of operation at specified power levels.

1.1 SUBSYSTEM ELEMENTS. The specific subsystem elements governed by the requirements of this plan, with the prime contractor's specification number for each are as follows:

	Element	Southwic Specification
1.	Antenna Selector	5-15001
2.	C Band Directional Antenna (2 each)	5-16001
3.	Antenna Control Unit	5-21001
4.	C Band Data Transmitter	5-22001
5.	C Band Beacon Receiver	5-23001
6.	Ku Band Directional Antenna Assembly	5-30001
7.	Ku Band Omni Antenna Assembly	5-31001
8.	Ku Band Beacon Receiver	5-32001
9.	C Band Beacon Transmitter	5-34001
10.	Ku Band Data Transmitter	5-25001
11.	C Band Data Receiver	5-36001
12.	Ku Band Beacon Transmitter	5-41001
13.	Down Converter	5-42001
14.	Receiver Demodulator	5-51001
15.	C Band Omni Antenna (2 each)	5-16901
16.	Tracking Link Modulator	5-39001
17.	Tracking Link Demodulator	5-28001

1.2 APPLICABLE DOCUMENTS. The following specifications form a part of this Control Plan. Subsidiary documents referenced in the publications shall be used to the extent specified herein:

MIL-STD-461A	Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-STD-462 and Notice 1	Electromagnetic Interference Characteristics, Measurement of
MIL-W-5088C	Wiring, Aircraft, Installation of
MIL-B-5087B (ASG)	Bonding, Electrical, and Lightning Protection, for Aerospace Systems

2.0 EMC MANAGEMENT. Duron Corporation philosophy requires that interference generation and susceptibility characteristics be considered and controlled as a natural function of design engineering. The Duron Corporation EMC organization that ensures that this philosophy is carried out is shown in Figure 1. The organization and control loops shown in the figure have been successfully used by Duron Corporation on many past programs and have been developed into a precise and highly refined technique that leads to total with compliance specifications and close coordination of all EMC effort with the Duron Corporation customer (Southwic Aircraft Corporation, in this case).

2.1 EMC PROGRAM MANAGEMENT PERSONNEL

Duron Program Manager:	J. J. Barnes		
Duron Systems Engineer:	P. Wilson		
EMC Systems Engineering Sub-Contractor:	ELECTROMAGNETIC LABORATORIES Assigned to: E. M. Potter		
Duron Mechanical Design Engineer:	A. Presly		
Duron Electrical Design Engineers:	Transmitters	–	R. Smithyson
	Receivers	–	J. Barney
	Antenna Array	–	M. Nielson
	Antenna Servo	–	P. Flemming
Duron Supplier Liaison Engineer:	J. Fischer		

Technical contact with Southwic Aircraft Corporation will be made through their EMC systems engineer, P. Parsons.

2.2 During all phases of this program, the interference control systems engineering will be accomplished by subcontractor specialists under the direction of the Duron Systems Engineer. Directions to the Duron design groups will be made in writing by the EMC systems engineering subcontractor and routed through the Duron systems engineer for concurrence before they are carried out.

2.3 Copies of all written data, performance calculations, analyses, and recommendations relating to EMI control will be incorporated into this Control Plan by revision. This will provide both Duron and Southwic with the technical basis for a thoroughly effective EMC program.

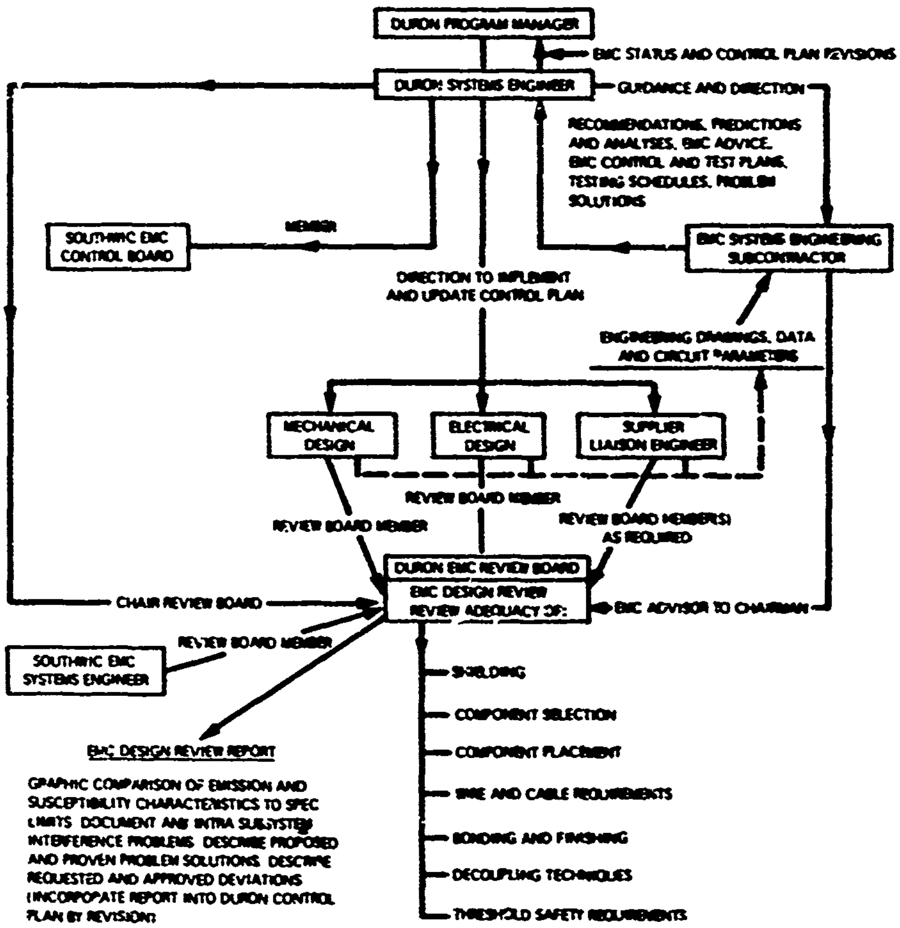


FIGURE 1 EMC PROGRAM MANAGEMENT

3

2.4 Duron Corporation will actively participate in the technical activity of the EMC Control Board, which will be chaired by Southwic. It is expected that Southwic will require further technical inputs from Duron. Experience with similar working groups indicates that the planned format and contents of this Control Plan document will fulfill most of the anticipated requirements, including circuit dynamics at the Duron interface. It is expected that Southwic will provide Duron with necessary data during EMC Control Board meetings.

2.5 Duron subcontractors, including component suppliers in many cases, will be required to abide by the requirements in this Control Plan. If a supplier asks that he be allowed to develop an EMI control program especially suited to his particular need, his request will be granted by Duron. The approval is based upon the provision that such supplier furnish a detailed interference Control Plan to Duron within 30 days after approval of the request and that the plan as furnished merits approval for use on this program.

2.5.1 If MIL-STD-461/462 tests have been performed by a supplier upon a component or unit similar to that procured by Duron for use in this program, the test report may be submitted to Duron for evaluation of applicability under the requirements of this Control Plan. Duron may, at their option, accept such data as evidence of a satisfactory interference control program within the Duron area of equipment design responsibility. This shall in no way relieve the supplier of his obligation to meet the requirements of MIL-STD-461/462 in final subsystem tests.

2.5.2 All subcontractor and supplier EMC effort will be recorded in written form and incorporated into this document by periodic revision.

2.6 EMC PROGRAM SCHEDULE. Figure 2 shows the EMC program schedule. The data submittal dates are marked with triangles. An EMC design review occurs at least every two months; however the Duron Design Review Board may meet more often if EMC problems arise that require prompt solution.

3.0 FREQUENCY MANAGEMENT. The Duron Corporation philosophy includes a strong emphasis on frequency management as an important element of its EMC program. It will be the responsibility of the Duron systems engineer to ensure that proper emphasis is placed on all phases of frequency management by the mechanical and electrical design groups, the suppliers, and the EMC Systems Engineering Subcontractor (Figure 1). Frequency management consists of:

1. Selection of optimum operating frequencies for all receiving and transmitting equipments when these frequencies have not been specified by the contract.

2. Selection of optimum types of modulation and circuit design to meet operational requirements and yet reduce the bandwidth of desired emissions to a minimum.

3. Selection of circuit design and mechanical design features that will either eliminate or reduce all spurious and unnecessary electromagnetic emissions to a minimum level. This applies to all electrical, electromechanical, and electronic devices regardless of their function.

4. Selection of circuit and mechanical design features that will reduce the susceptibility of all electrical and electronic equipments and devices to undesired interference effects such as undesired reception, undesired operation of relays and other electromechanical devices, reduction of performance below specified

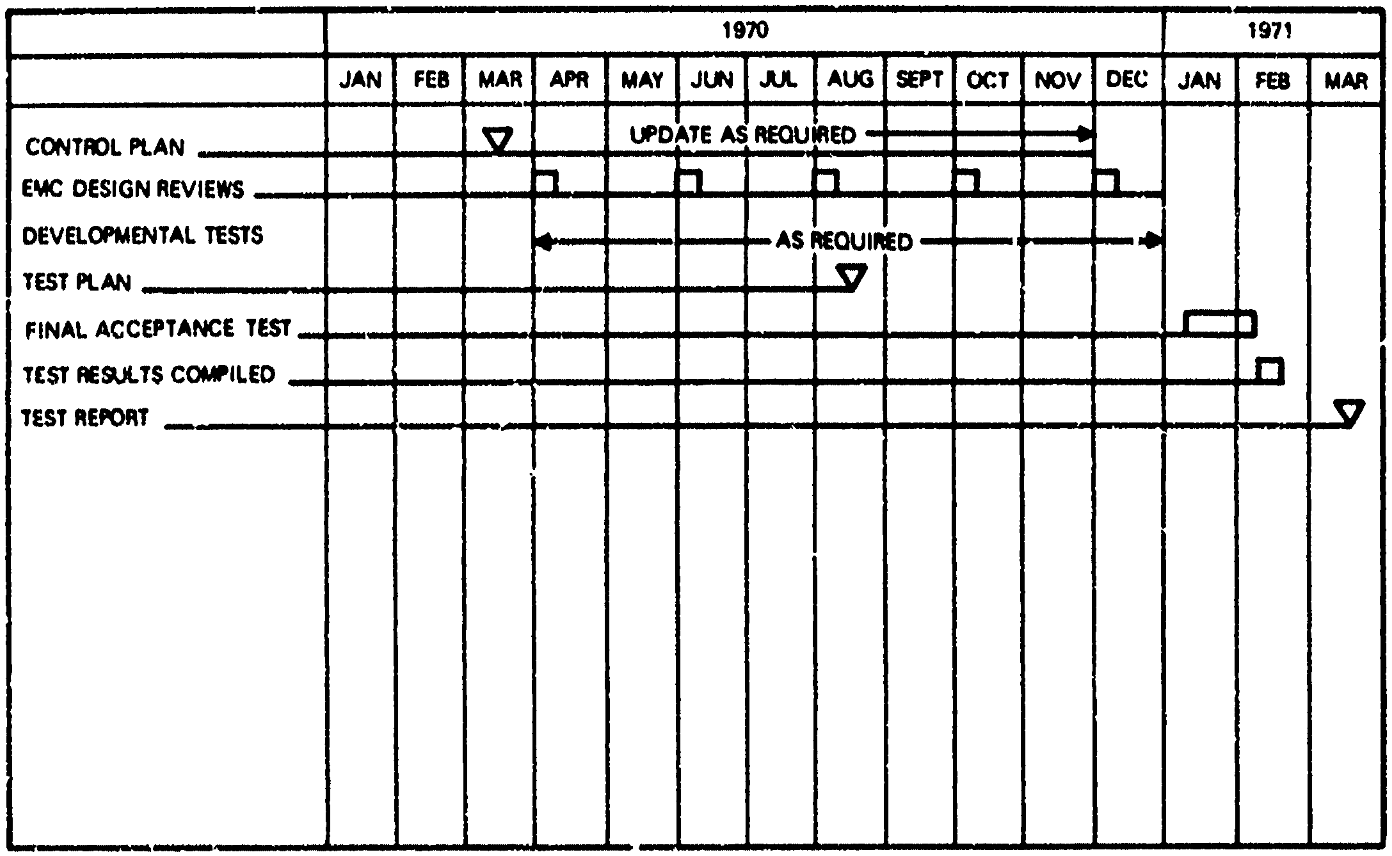


FIGURE 2 EMC PROGRAM SCHEDULE

levels, any malfunction or failure that will permanently damage or endanger personnel.

5. Selection of pulse shapes, power sources, digital circuits, high current interrupting devices so that all subsystem equipments and devices will emit a minimum of undesired electromagnetic emissions and be the least susceptible to any spurious or undesired emissions from within or outside the subsystem.

4.0 MECHANICAL DESIGN. The mechanical design features for all subsystem elements will be governed by the following requirements, which constitute the minimum constraints placed upon circuitry designed to meet the limits of MIL-STD-461A.

4.1 ENCLOSURE SHIELDS (CASE). Each basic enclosure will be designed to contain the signal level that can be radiated from the circuitry within such enclosure. The degree of attenuation required for the basic enclosure will be derived from analysis (calculations) of the various circuits contained therein. In some instances, an analysis need not be made if the actual radiated power level is already known. The levels will be compared to the MIL-STD-461 limit for each type of signal encountered. The difference between each existing signal level and the MIL-STD-461 limit for such a signal (plus a 6 dB safety factor) will be used as the performance requirement for the shield. An additional consideration will be made wherein the susceptibility field levels required by MIL-STD-461 will be compared to the most sensitive circuitry within the shield. The difference between these levels, if greater than the value first calculated for a containment shield, will be used as the performance requirement for the shield. See Table 1 for basic performance data.

4.1.1 Care should be taken when using the techniques discussed above to ensure that the required value of enclosure shield attenuation is not compromised by cable penetrations or meter faces. The shield is only as good as its weakest penetration point. This could be, and often is, the point at which the cables are routed into and out of the unit. Cables routed from the unit, particularly those directly connected to the source of highest generated interference levels, can cause problems if the cable shield, for example, is not as good as the case outer shield. For most purposes, a typical shielded wire pair offers maximum interference reduction in the radiated field on the order of 60 to 65 dB varying downward as frequency is increased. There are exceptions to this performance figure, but these exceptions are special cases. Therefore, for this EMC program typical cable shields will be considered as nominal 60 dB attenuation shields. Thus, if a cable does not have some special shield arrangement, the case outer shield cannot be considered as being any better than 60 dB. Higher case design values under these circustances merely result in a weight penalty.

4.2 COMPARTMENTS. Within each enclosure, separate compartments will be provided as necessary to eliminate the deleterious effects of coupling between non-compatible circuits. An example of a situation where compartmentizing is necessary is in a unit where receiver circuitry must be packaged in a common enclosure with transmitter circuitry. In this case, the passband characteristics and sensitivity/output power respectively, must first be known for both types of circuits. If there is any case where the receiver passband overlaps the transmitter output band, a comparison must be made between receiver sensitivity at that frequency and the transmitter output power. Should the latter fall within -6 dB of the receiver threshold, an internal shield must be used to seperate the circuits. There are additional parameters that must also be evaluated before such a shield may be successfully used. Receiver spurious

Table 1

Aluminum Equipment Enclosure Shielding Performance Data

This table of attenuation values will be used to evaluate the shielding effectiveness of standard aluminum equipment enclosures. These values are generally orders of magnitude less than calculated values based upon a "perfect" enclosure fabricated from the same material. This is due to the fact that an equipment enclosure usually contains a large number of potential RF leaks. The point of maximum leakage determines the maximum shielding effectiveness.

Frequency	Attenuation 20-mil minimum thickness
10 kHz	35 dB
100 kHz	72 dB
500 kHz	76 dB
1 MHz	80 dB
10 MHz	82 dB
50 MHz	86 dB
100 MHz	90 dB
500 MHz	88 dB
1 GHz	88 dB
2 GHz	85 dB
4 GHz	79 dB
8 GHz	72 dB
10 GHz	65 dB

Note: At frequencies above 50 MHz, attenuation on the order of 100+ dB may be realized if care is taken to ensure that line filters continue to operate properly and cable shielding is grounded (preferably to the outer envelope) as directly as possible without the use of "daisy chain" arrangements.

response and transmitter spurious output characteristics must be known. Possible spurious interactions may require a higher degree of shield performance than was first determined. There are also other aspects to be evaluated. For example, the coaxial cable shielding performance must be known if the receiver input is routed through the transmitter compartment and vice versa. Failure to properly assess this latter condition can totally invalidate the design of an otherwise adequate shield.

4.3 CIRCUIT SHIELDING. In addition to the interior compartments that will be designed to serve as shields, precautions will be taken to ensure that certain types of circuits are protected from the adverse influence of adjacent "noise" generation circuitry or are shielded to contain internally generated "noise." For example, IF strips will be shielded from other circuits of all types through the use of self-contained compartments. Input power leads to this type of circuit will be routed through feed-through types of decoupling terminals. Signal inputs and outputs will always be routed via coaxial cable with the protective shield grounded where it enters and leaves the IF compartment. An example of the use of a containment shield is the enclosure for a local oscillator. In this case, all input power is decoupled at the point of entry to the enclosure to prevent feedback of internally generated signals into the power source. If the oscillator is voltage controlled, all control leads will be decoupled or filtered at the point of entry into the oscillator enclosure. The output signal will always be routed via coaxial cable, with the outer braid grounded at the point where the cable is routed from the enclosure. Covers for these types of relatively small internal shielded units will be RF gasketed or will be provided with a tight interference fit to seal against possible RF leakage (Figure 3).

4.4 SEAM IMPEDANCE. The RF impedance of any seam or closure discontinuity must be electrically similar in RF impedance to the intrinsic impedance of the metal from which the enclosure is made. This is important because voltage drop across an impedance discontinuity generates a field that appears as a leak in the shield. The impedance across environmental finishes such as anodic films is intolerable. In the case of anodic finishes, serious RF leakage characteristics predominate, as in the following example:

1. Assume a cover plate is separated electrically from an enclosure by an anodic finish. This will cause the cover plate to become a very effective radiator at frequencies that correspond to dimensional resonance or at wavelength functions as low as $f_R = \lambda/10$. In some instances, the cover radiator will afford a gain figure and the external radiated field can exceed the level of the unshielded source of interference generation.

2. The slot around the periphery of the cover, because of its electrical isolation from the enclosure, becomes an effective slot radiator. Its effect is very similar to the description above.

3. Because the cover plate is not electrically homogenous with the enclosure, noise currents are allowed to flow on the outside surfaces of the enclosures and along shielded cables and bonding straps. In many cases this accounts for the presence of standing waves on equipment enclosures and cable shields. It has been noted in the technical literature that a non-bonded seam as short as six inches can totally destroy the effectiveness of a -100 dB (attenuation) enclosure of 20 ft. X 20 ft. at a frequency of 400 MHz.

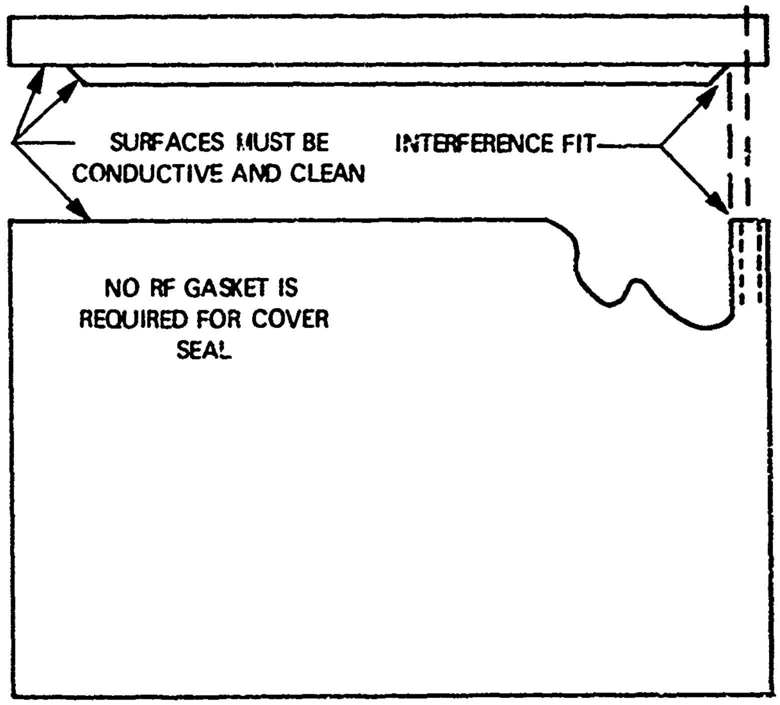


FIGURE 3 METHOD OF RF SEALING USING AN INTERFERENCE FIT

4.5 SEAM BONDING. There are several possible methods of seam bonding, all of which are satisfactory for EMI/EMC control if used properly. The choice of method is dictated by considerations such as maintainability, accessibility, and structural durability. In preferred order, the acceptable methods of seam bonding are:

1. Welding: A bond using a weld alloy or parent metal filler that closely approximates the basic enclosure material. In the ferrous group, the carbon content match is most important for optimum magnetic shielding.

2. Brazing: This is not a recommended practice for fabricating magnetic shields since the filler material does not perform well unless the magnetic source is several wavelengths distant from such a brazed area.

3. Soldering: Not recommended for magnetic enclosures and extremely unreliable for structural purposes. Offers excellent conductivity across mechanically well-designed joints and seams. Can be used to good advantage in sealing subcircuits such as IF strips and oscillators.

4. Gasketed Joints: Gasketing can be used at almost every type of seam and is effective over a wide range of frequencies. There are, however, certain precautions to be taken and there are limitations regarding its use. These aspects are:

   A. Woven Wire Gaskets:

      (1) Work well at the lower frequencies up to approximately 400-500 MHz.

(2) If a combination woven wire-environmental seal type of gasket is used, the environmental seal should be installed so as to protect the gasket against the undesirable environment.

B. Finger Stock Gaskets:

(1) Work well in the higher range of frequencies from 10-15 kHz through frequencies above 10 GHz.

(2) Do not depend upon finger stock gaskets for magnetic field control unless the finger stock is installed in multiple rows. In any case, finger stock is not very dependable in the magnetic realm below 5-8 kHz.

(3) Maximum attenuation that can be expected from a single row of finger stock is about 60 dB.

(4) The use of finger stock is generally not advisable in most cases because it is expensive and the cost of incorporating it into most design configurations is prohibitive.

(5) If finger stock is used, it must be protected from damage, since it is unusually brittle and can only be flexed in one direction.

C. Conductive Sealing Materials (paste, rubber, etc.)

(1) The use of conductive sealing materials will, in many cases, result in many problems, most resulting from the fact that these types of materials are poor RF conductors.

(2) The conductive pastes and epoxies can only be used to advantage on assemblies that are non-repairable. This is because, upon disassembly, the surfaces to which this material has been applied must be stripped to clean metal, and this is generally impractical, if not impossible, to do. Field maintenance facilities also do not generally have the exact replacement material available. Therefore, EMI problems may result from inability to maintain adequate shielding after disassembly and re-assembly.

(3) Should conductive pastes or epoxies be considered for incorporation into equipment, a test must first be performed to ensure that the material will do the job. The test must duplicate the actual configuration considered for use.

(4) Conductive rubber as well as paste and epoxy are unit resistance rated at DC. There is no possible means by which RF impedance can be determined except through actual testing.

4.6 BONDING AND GROUNDING. Each unit will be bonded or grounded to the mounting structure as an integral feature of the Duron design. The method being developed to meet MIL-B-5087 requirements is shown in Figure 4. This design will be analyzed in detail to determine specification compliance without compromise over an extended period of time. This preferred method, as shown, will eliminate the need for bonding straps, which in some instances are not properly restored after maintenance. If the analysis indicates any deficiency in the design, conventional bonding

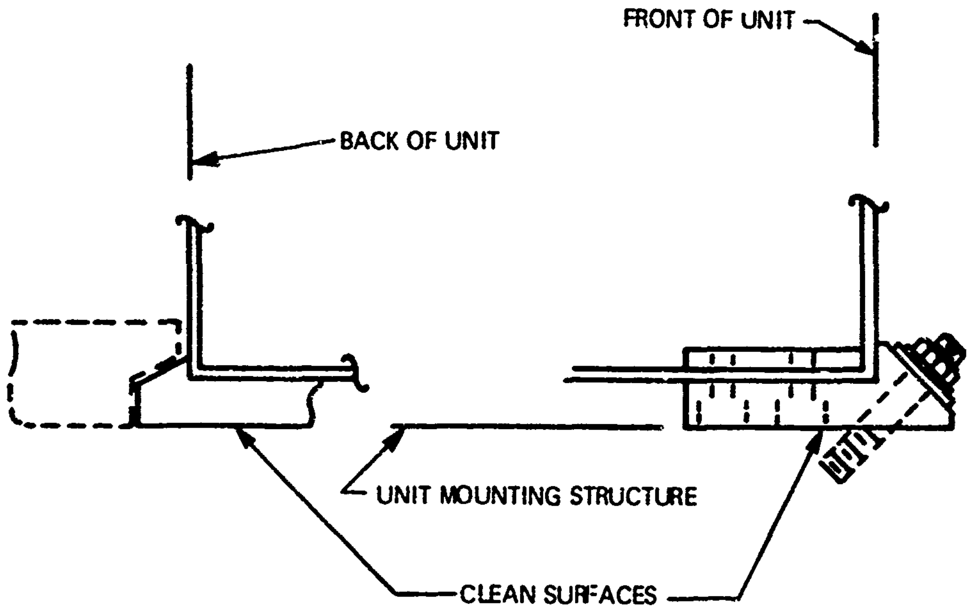


FIGURE 4 METHOD OF BENDING A UNIT TO MOUNTING STRUCTURE

provisions as shown in Figure 5 will be used. In this latter configuration, a burnished, paint-free area is provided around a tapped hole in the unit enclosure. The tapped hole provides a convenient and conventional means of attaching bonding straps.

4.7 PANEL MOUNTED DEVICES. All panel mounted devices such as switches, electrical connectors, indicators, and control shafts must be totally shielded assemblies or must be installed in a special manner. Typical treatment of these devices is described below:

1. Elapsed Time Indicators: These should be procured by specifications that require that the meter will fulfill the requirements of MIL-STD-461A. Preference should be given to meters operating from AC line voltage, since these meters can more readily meet specification limits without extensive rework. Avoid procurement of meters finished with an anodic film. Although they may individually meet specification limits in bench tests, the presence of an anodic finish constitutes a panel leak, since after installation they represent a panel aperture.

2. Switches: Panel switches must be well grounded to the panel with clean metal-to-metal contact. For most purposes, toggle switches may be used without any special rework and RF integrity of the enclosure will be preserved. In special cases such as with numerical indicating switches, the units should be purchased by specifications that require performance demonstration of shielding integrity both when unloaded and when switched under load. The application of anodic finishes to switches is expressly prohibited.

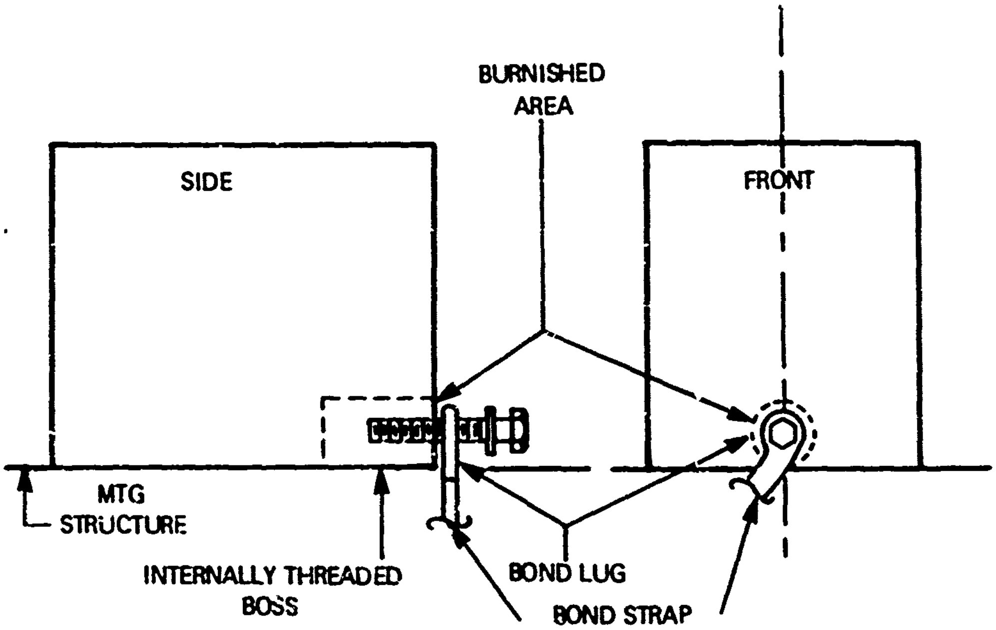


FIGURE 5 OPTIONAL METHOD OF BONDING A UNIT TO MOUNTING STRUCTURE

3. Panel Mounted Control Shafts: Any control shaft that protrudes through an equipment front panel must be well grounded from the shaft proper through the mounting collet to the panel surface. If the normal hardware does not provide the desirable low impedance path, a finger stock shorting ring or a mesh gasket installed within a compression gland must be used to ground the shaft. An alternate method consists of replacing the metal shaft with a dielectric shaft. This latter control shaft must be routed through a cylinder that will act as a waveguide below cut-off. The cylinder waveguide should preferably be brazed or welded to the front panel and its length vs. diameter is governed by the following considerations:

$$F_c = \frac{6920}{\text{dia}}$$

Where:

F_c = cutoff frequency in megahertz

dia = diameter in inches

and

$$\text{atten} = 32\frac{\ell}{d}\ \text{dB}$$

Where:

ℓ = length in inches

d = diameter in inches

Thus:

a ratio of 3 for $\frac{\ell}{d}$ gives approximately 100 dB attenuation.

The tube cutoff frequency should always be at least two times the highest frequency at which EMI control or containment is desired.

5.0 ELECTRICAL/ELECTRONIC WIRING DESIGN. To reduce interaction between different elements of the subsystem, all subsystem wiring shall be analyzed to determine interference and susceptibility levels, and appropriate action shall be taken to eliminate apparent interference situations.

5.1 WIRING MATRIX. A complete wiring matrix showning means of termination, type of cable or wire, pin designations, type of signal, shielding, and grounding details will be compiled in the form shown in Figure 6. Subcontractors will provide this same data to Duron Corporation as part of their data package.

5.2 RF CONNECTORS. A detailed description and illustrations of the mounting and grounding provisions for RF connectors are included in Figure 7.

5.3 ELECTRICAL CONNECTORS: The mounting and grounding provisions for typical electrical connectors is also illustrated in Figure 7. Further requirements for electrical connectors on each unit are included in the interference control requirements of Appendix A.

5.4 POWER DISTRIBUTION. All AC power required by the units will be three phase 115/200 volts at 400 Hz. Input power will be routed from source to load (unit) via a four wire twisted quad distribution system. The neutral will not normally be grounded at the load. The neutral will, however, be grounded at the source bus.

5.4.1 Secondary power (after conversion) will be routed via twisted pair distribution cables for DC and single phase AC. The neutral will not be grounded except at the source. Care shall be taken to ensure that the airframe is not intentionally or otherwise made a return conductor for DC or power frequency AC.

5.4.2 In those cases where various DC voltages are provided by a common power supply, only one neutral wire need be routed to any given load.

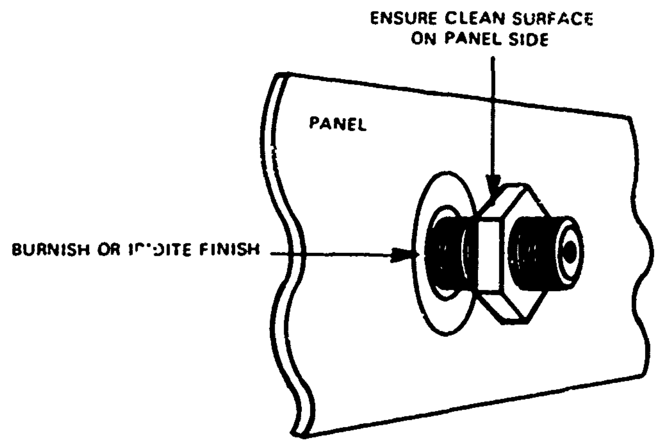
5.4.3 Primary input power will not be routed in shielded cable. Twisting, as necessary, is the preferred method of reducing the magnetic field. Secondary power may be routed through shielded cable with the shield normally grounded at the source end only. Where RF signal noise may be impressed or coupled into secondary power cabling, it may be necessary to ground the shield at both ends or provide filters at the load end. A specific analysis shall be made of each such case.

5.5 SIGNAL CATEGORIES. A design concept using categorization of interconnecting wires and cables has been developed. Interconnecting wiring is isolated in accordance with the following criteria. A minimum of 3 cm is maintained between wires or wire bundles of the different categories, except when different categories use the same connector. In such a case, pin assignment and layout shall be fully used to isolate different categories, and grounded spare pins shall be used to provide necessary isolation. In some cases, isolation may be required between various circuits within a particular category, depending on frequency, voltage, and sensitivity. For purposes of this program, six categories will be considered:

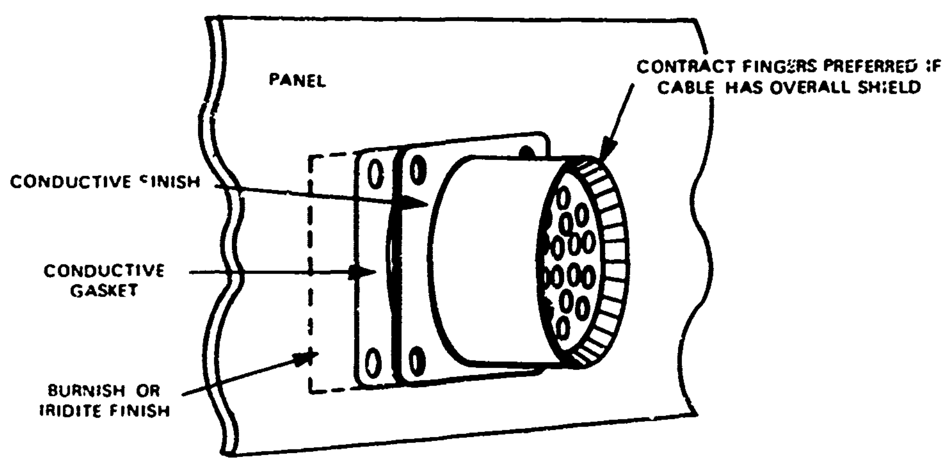
1. Power Circuits: Power circuits include both AC and DC distribution networks, whether primary or secondary after conversion. These circuits will never be routed with any other category of cables, since they are characteristically sources of relatively high level magnetic fields.

UNIT	CONNECTOR NUMBER	PIN	SIGNAL TYPE	VOLTAGE	ALLOWABLE NOISE	FREQUENCY BANDWIDTH	FUNCTION	Z OHM	CIRCUIT TYPE

FIGURE 6 WIRING MATRIX



TYPICAL METHOD OF
MOUNTING SUB-MIN. RF PANEL
CONNECTORS



TYPICAL METHOD OF MOUNTING
ELECTRICAL CONNECTORS

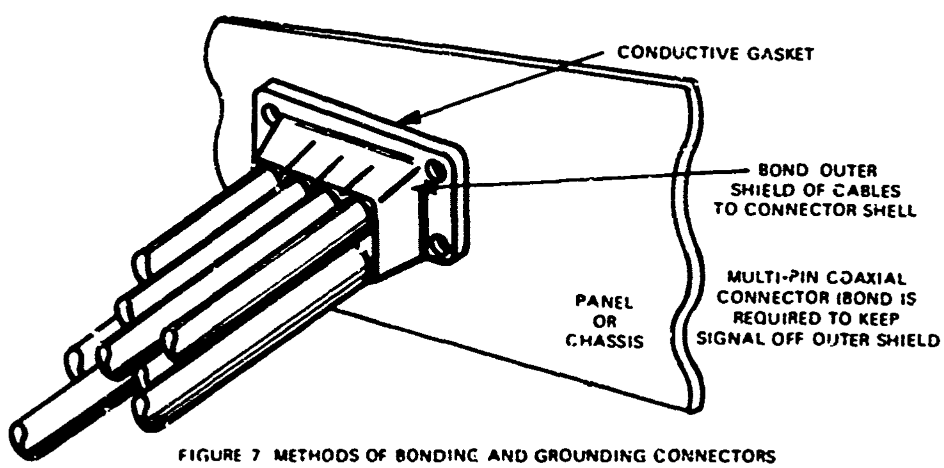


FIGURE 7 METHODS OF BONDING AND GROUNDING CONNECTORS

2. Audio Circuits: These circuits consist of signal distribution networks operating at frequencies below 150 kHz. A pulse circuit regardless of its repetition rate is not considered an audio circuit.

3. Indication Circuits: In this program, this signal category will be limited to signals such as synchro outputs/inputs as chiefly related to antenna positioning circuits. Step function control and position/ mode indicating signals are not included in this categroy.

4. Control Circuits: This category includes step function type control and indication circuits where the characteristic signal introduced into such circuit is broadband. These circuits are sources of RF radiation in most instances since the normal signal may appear as a transient that must meet specification limits for steady state interference. Pulse circuits are included in this category.

5. Sensitive Circuits: This category can include any other category of signal if the specific circuit being considered is extremely susceptible to extraneous interference voltage or current. In addition to the fact that this group must be separated from any other group of signals, it is very seldom that a circuit in this group will be routed as a single ended, unshielded wire. Therefore, all interconnections falling within this category will be routed as pairs, triads, etc. and will include the common or return wire in twisted configuration with an overall shield.

6. RF Circuits: By definition, this group only includes receiver input, transmitter output, and IF cables. In every instance, they are routed via coaxial cable or waveguide according to future requirements. Transmitter cabling may not, under any circumstances, be bundled with receiver RF cabling. Separation distance between any transmit and receiver cables will be based upon specific data for the isolation and containment provided by the actual cable or waveguide used. The separation requirements will be determined by obtaining and using all necessary data, including that provided on the wiring matrix (Figure 6).

5.5.1 The following category designations will be used to identify the signal type when cable data is entered in the matrix shown in Figure 6.

Category	Signal Type
I	Power circuit
II	Audio circuit
III	Indication circuit
IV	Control circuit
V	Sensitive circuit
VI	RF circuit

6.0 ELECTRICAL/ELECTRONIC CIRCUIT DESIGN. In circuit design, before any interference control components are considered, the amount of interference inherently generated and propagated will be minimized. Consideration will be given to: (1) conservation of spectrum bandwidth; (2) control of operating frequencies and associated harmonics, sidebands, and spurious products, (3) control of pulse amplitudes and rise times; and (4) any other factors affecting interference generation. The equipment shall also be designed to minimize susceptibility to interference from other sources. When all due care in design has been exercised and yet it is found necessary for interference control components to be used, as in filtering, shielding, and bonding, they shall conform to applicable military specifications and be an integral part of the system.

6.1 USE OF INTERFERENCE CONTROL COMPONENTS. The requirement for use of any suppression network, filter, or shield will be proven mathematically before its incorporation into the equipment or sub-system. The gross installation of suppression networks and shields is prohibited and will not be accepted as a sound approach toward EMI control.

6.1.1 The incorporation of any EMI control technique or method will be justified by a rigorous design analysis of the particular component, circuit, or equipment to be suppressed or protected. These analyses will include the following data:

a) Calculations of the "worst case" condition that will be reduced to graphic form to reflect interference amplitude vs. frequency dispersion.

b) Performance data for the exact network or shield proposed for use in attaining specification compliance. In the case of suppression networks the type of circuit shall be stated, such as pi, L and T and the values of L, C, and R shall be stated whenever possible.

c) Performance data for any network must be stated in terms of actual load and impedance conditions.

d) If the network was successfully used in a similar circuit on a previous program, test results or other descriptive data that reflects actual performance should be included.

6.2 CHOICE OF SUPPRESSION NETWORKS. Whenever possible, first consideration shall be given to the use of feed-through type capacitors in preference to the more complex networks such as T, π, and L configurations. Take care to avoid the use of series elements whenever possible in order to maintain high reliability. The following criteria will be followed in choosing the networks to be used:

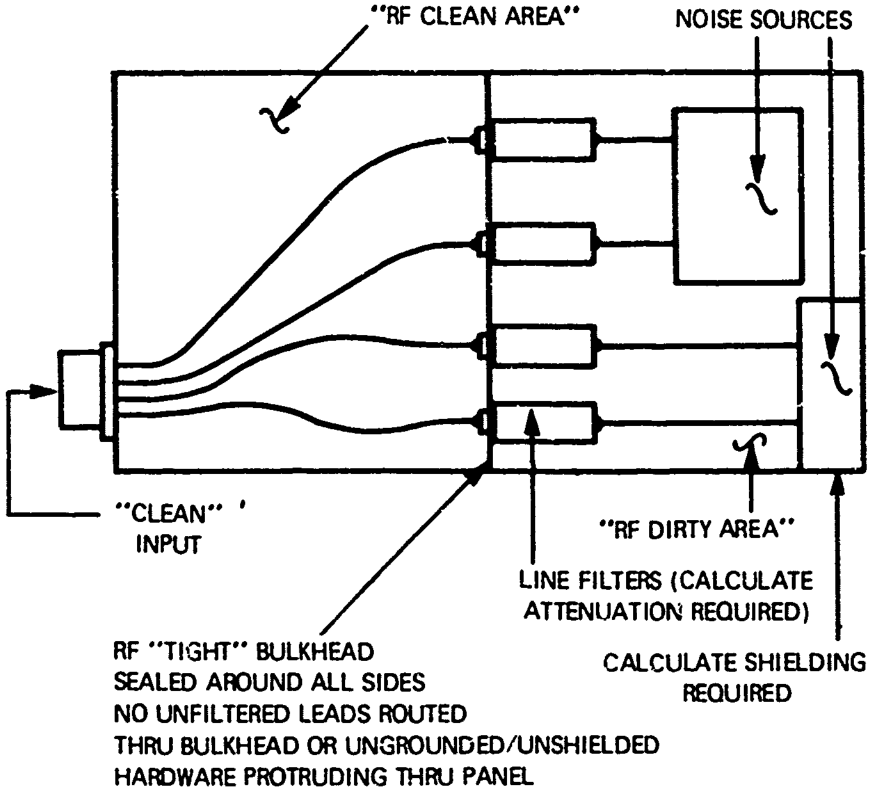
1. When calculating the requirements for filter performance, the 10 ufd input power line capacitor required by MIL-STD-462 shall be assumed to be 0.1 ohm impedance. The power supply output capacitance of 100-500 ufd is considered in parallel with the 10 ufd capacitor.

2. Pi type networks or capacitors will never be used on both sides of switched contacts. This practice results in unusually high rates of contact deterioration.

3. Line-to-line filter configurations will be used wherever possible. This network style is preferred to eliminate the necessity for grounding the power neutral inside the equipment envelope. Expected performance will be calculated and provided to Duron by all subcontractors.

4. When feed-through capacitors and filters are used, they will always be bulkhead-mounted units. Input wiring to filters will never be routed with output wiring. (Figures 8 and 9).

5. Subcontractors who use filter networks to meet the requirements of MIL-STDS-



NOTE: BULKHEAD FILTERS REQUIRE LOW Z GROUND PATH IN ORDER TO YIELD REQUIRED ATTENUATION. THIS LOW Z MUST EXIST ALL FREQUENCIES OVER WHICH FILTER MUST WORK

FIGURE 8 TYPICAL USE OF BULKHEAD-MOUNTED FILTERS

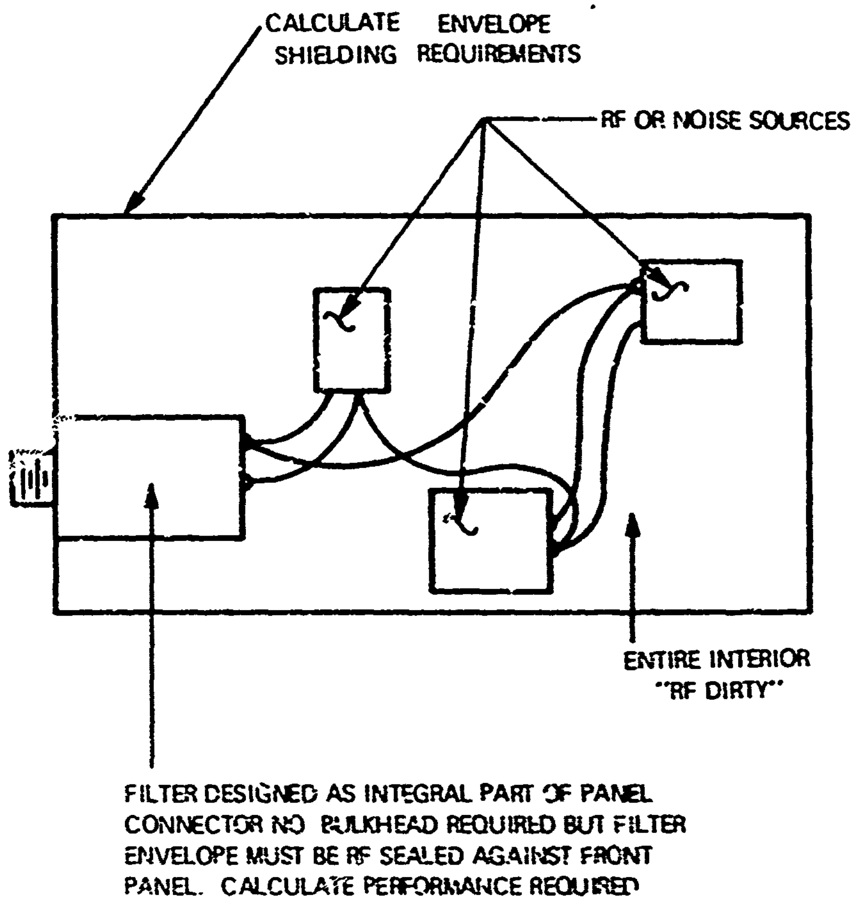


FIGURE 9 USE OF INTEGRAL FILTER-ELECTRICAL CONNECTOR

461/462 will advise Duron Corporation regarding the type of network proposed. This must be done before the filter network is entered on the design drawing. The performance requirements for any such network must also be included in the data package transmitted to Duron Corporation for EMI/EMC review.

6.3 POWER CIRCUIT SUPPRESSION NETWORKS. The following criteria will apply to design of power circuits.

1. Input power will be decoupled through the use of filter networks. Before installation of any such network, a detailed analysis will be performed.

2. Under normal circumstances, input power will be grounded only at the primary source. In some instances, particularly those where the load consists of an equipment that generates RF above several megahertz, it may be necessary to include a filter network in the power neutral leg of the input circuit. This occurs since the ungrounded neutral that penetrates the equipment envelope can act as an efficient RF pickup probe. Accordingly, this lead may carry

undesirable interference fields out of the equipment and will reradiate these fields or conduct them back to the power source bus. If a filter network is installed in the neutral or return leg of an input circuit, an analysis will be made to ensure that the filter will not detract from the specified operational characteristics of the equipment.

3. If an analysis of the power input circuits indicates a necessity to ground the neutral at the load, the actual ground point will be a terminal on the "clean" side of the power input filter. The neutral will never be routed to any other ground point within the equipment.

4. In many instances, the use of a simple "L" type filter will provide adequate decoupling at the power input leads of any of the various equipments or loads fed by a power system. When such a filter is used for interference suppression, the following should be considered:

   A. In DC and single phase AC circuits, the preferred method is to connect the shunt capacitor of the "L" type filter on the load side of the series inductor (Figure 10). The analysis performed on each decoupling circuit will indicate if the alternate method should be used.

   B. In three phase (3ϕ) AC circuits with no neutral run to load, the preferred method of connecting "L" type filters in the input power leads of equipments is shown in Figure 11.

   C. Two methods for connecting "L" type filters in a 3ϕ, 4 wire system are shown in Figures 12 and 13.

5. Before taking the type of design action suggested by this paragraph, Southwic EMC systems engineering will be advised of the proposed design. They will concur with the proposed design before the actual installation.

6.4 SPECTRUM CONTROL – TRANSMITTERS. The spectrum will be controlled within transmitter circuitry by adhering to several basic techniques. First, all outputs from oscillators and frequency multipliers will be controlled in spectral content by the installation of bandpass filters. If the frequency thus generated is further multiplied or amplified, it will again be closely controlled by the introduction of an additional bandpass filter. The output of TWT amplifiers will also be closely controlled by the use of bandpass filters that will optimize energy in the desired intelligence passband and attenuate spurious signals outside of this band. Each such network will be critically analyzed and an integrated passband spectrum profile will be developed.

6.5 PASSBAND CHARACTERISTICS – RECEIVERS. Overall out-of-band rejection characteristics of receivers are controlled by front end passband shaping and in some cases is further aided by the directional characteristics and frequency response of the antenna. Sharply tuned post front end filters, coupled with the natural IF passband envelope, often yield the desired overall passband characteristics.

6.5.1 When the basic operation passband is extremely wide, two basic forms of selective filtering may be necessary. First, a passband preselector filter may be provided at the receiver end of the antenna transmission line. This filter will assure sharply defined pass/reject front end characteristics. The output of this filter will be fed to a low noise preamplifier. In the case of the C band beacon receiver, an additional amplifier will provide high gain-wide band amplification of the filtered input signal.

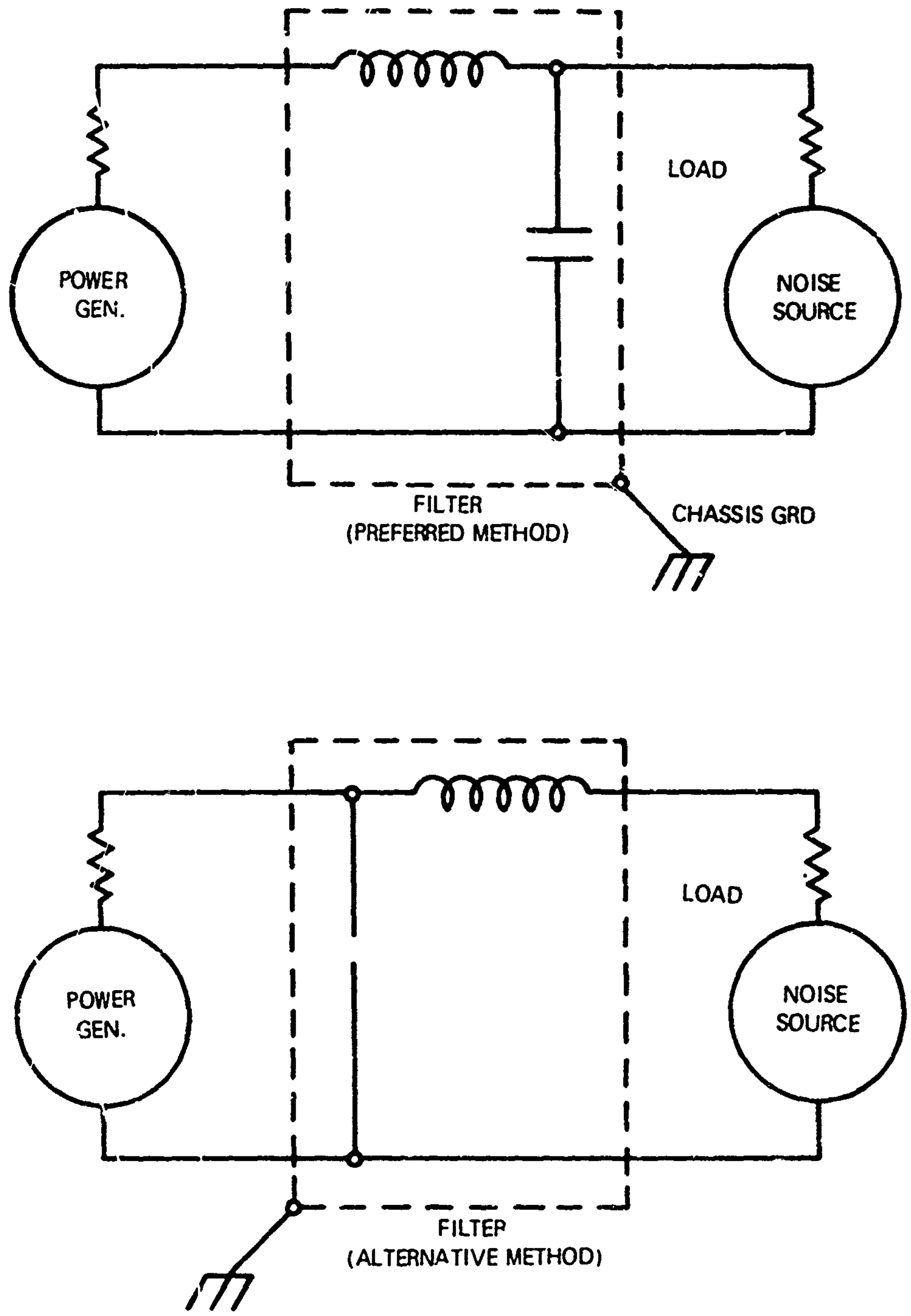


FIGURE 10 EMI FILTER CONFIGURATION

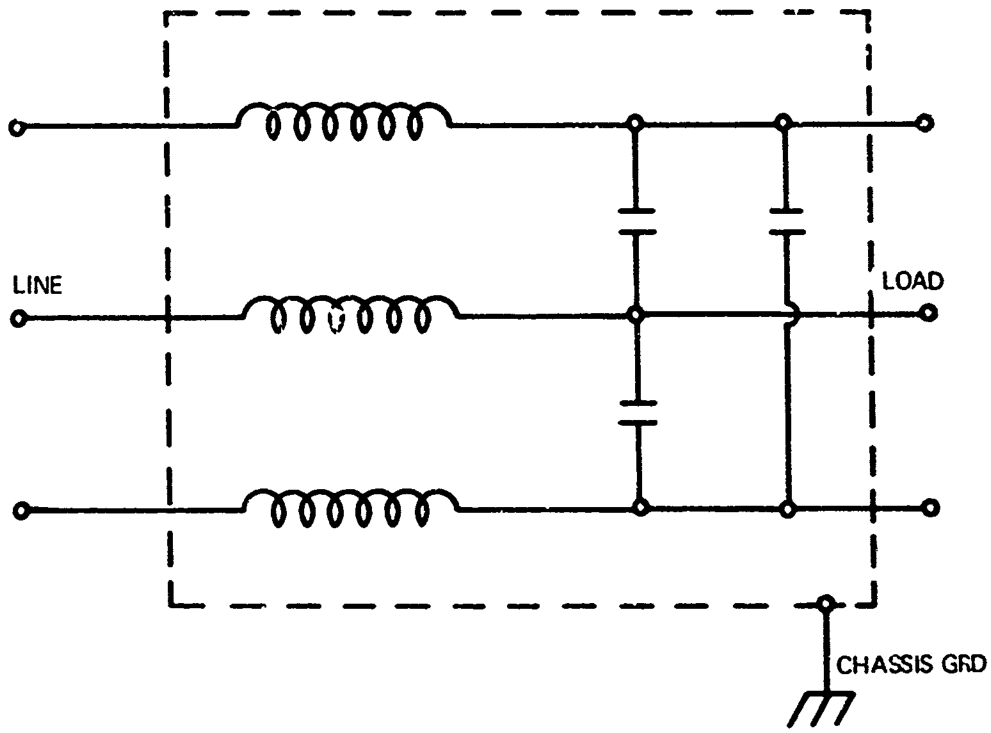


FIGURE 11 FILTER FOR 3Ø, 3 WIRE, UNGROUNDED LOAD

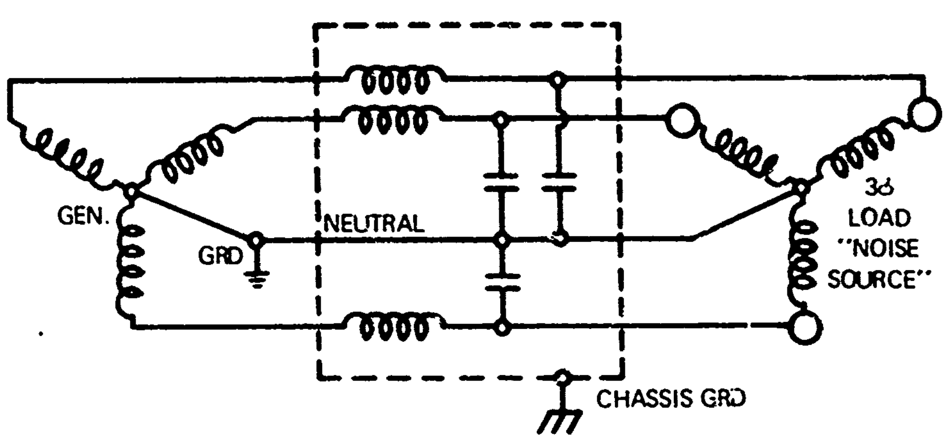


FIGURE 12 EMI FILTER FOR 3Ø, 4 WIRE POWER SYSTEM (PREFERED METHOD)

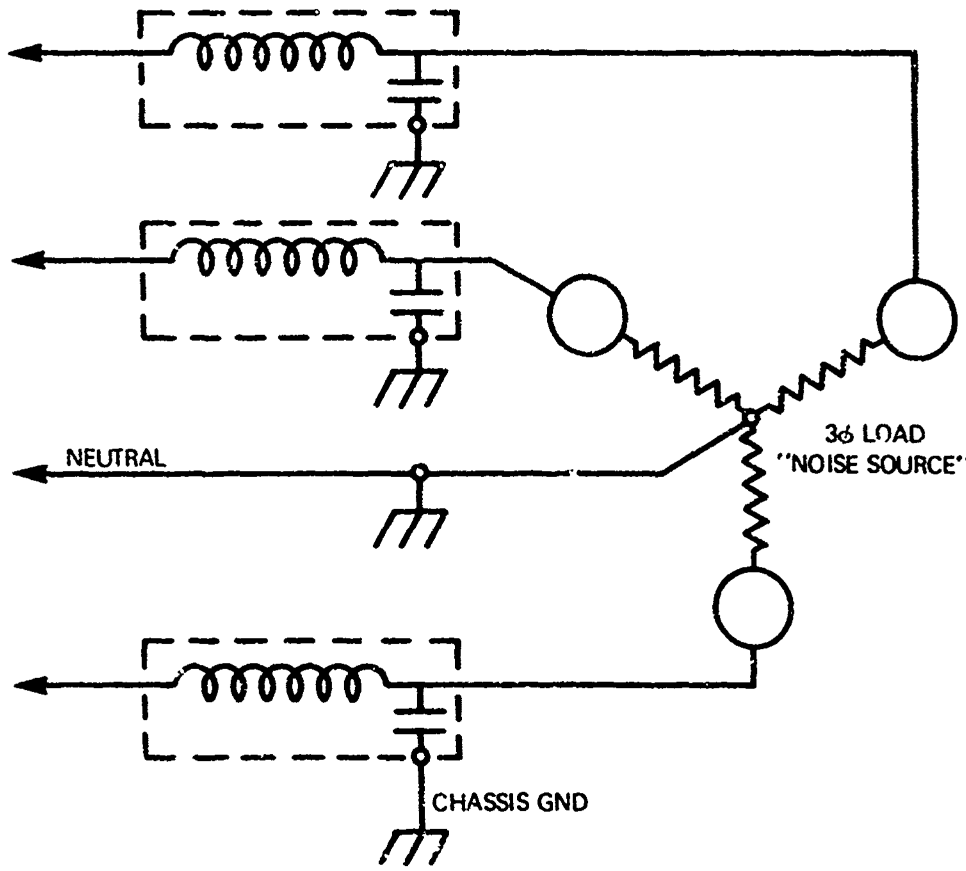


FIGURE 13 EMI FILTER FOR 3ϕ, 4 WIRE POWER SYSTEM (ALTERNATIVE METHOD)

6.5.2 The equipment characteristics and specifications governing filters and channel envelopes shall be used to conduct computerized "birdie" analysis to determine the specific pass/reject response for each receiver. Since these data are classified, they will not be included in this plan.

6.5.3 The data link equipment has constraints with respect to phase linearity. The phase distortion limits are ±8° peak-to-peak and quadrature phase distortion of 45° across a 100 MHz band. These phase constraints limit the selectability and bandwidth of filters that may be used in the equipment. The filter characteristics will be analyzed and reported as a part of the line filters and suppression networks analysis.

6.6 DESIGN CHECK LIST. A design check list will be prepared and distributed to each design engineer to prompt him to consider EMI problems in the early stages of design. Each engineer will review the check list and indicate his preliminary approach to ensure EMC. The check list, with examples of typical answers, is contained in Exhibit A.

7.0 ANALYSIS PROGRAM. Duron Corporation is fully aware that successful EMI control, both from the standpoint of emission and susceptibility, consists of implementing a thorough component, black-box, and subsystem oriented analysis program. This program is instituted during the initial design phases and carries through to final subsystem testing. The objective of the analysis program is to incorporate EMI control measures as a design function, thus avoiding costly test and rework in the latter program phases. Duron will work closely with Southwic interference control engineers to ensure that the final system meets all EMC requirements.

7.1 SUBSYSTEM ANALYSIS BREAKDOWN. Each equipment of the subsystem will first be individually analyzed for EMI emission/susceptibility characteristics. After completion of the individual equipment analyses, there will be a further task effort on a subsystem level. This effort will be designed to provide assurance that the subsystems will work together without mutual interference. The subsystem level groups are defined as follows:

A) <u>Sensor Subsystem Group</u>
   a) C band data transmitter
   b) C band beacon receiver
   c) C band antenna, directional (2 each)
   d) Antenna control unit
   e) Antenna selector
   f) C band omni antenna (2 each)
   g) Tracking link demodulator

B) <u>Relay Subsystem Group</u>
   a) Antenna control unit (2)
   b) Ku band directional antenna (2)
   c) Ku band omni antenna
   d) Ku band beacon receiver
   e) Ku band data transmitter
   f) C band beacon transmitter
   g) Antenna selector
   h) C band directional antenna (2)
   i) C band data receiver
   j) Tracking link modulator

C) <u>Surface Terminal Group</u>
   a) C band beacon transmitter
   b) Down converter
   c) Ku band beacon transmitter
   d) Receiver demodulator

7.2 BROADBAND INTERFERENCE ANALYSIS. All appropriate circuits and components such as relays, switches, trigger circuits, multivibrators, and pulse generators must be considered broadband interference sources. All such circuits and components will be mathematically analyzed and a graphic comparison made of the interference emission with the appropriate MIL-STD-461 limit, conducted or radiated. Figure 14 shows an example of such a comparison plot for broadband radiated emission, which includes the effect of shielding as discussed in Section 4.0 of this plan. Steps used in the mathematical analysis will be shown on the graphic plot, on additional pages as necessary, and added to this control plan as part of a future revision.

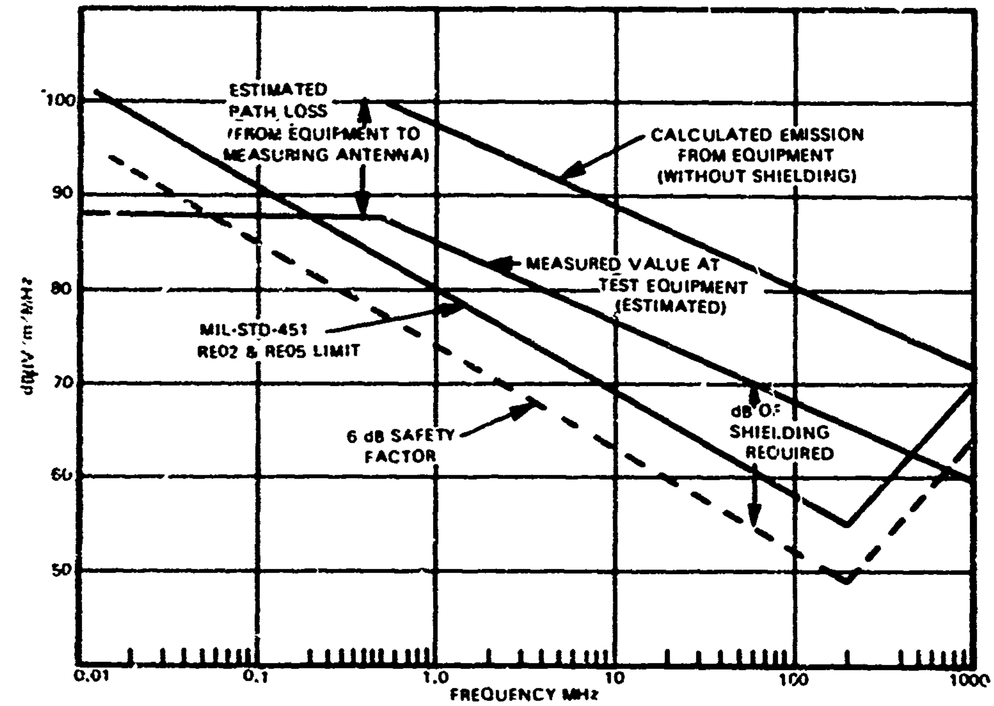


FIGURE 14 BROADBAND INTERFERENCE ANALYSIS PLOT

7.3 **NARROWBAND INTERFERENCE ANALYSIS.** Narrowband interference emission may be the result of a specific emitter designed to produce a particular frequency of specified power level, or it may be the result of an intentional or spurious emission at a certain frequency with an unspecified power level. All such emissions will be analyzed and a graphic comparison of the interference emission with the appropriate MIL-STD-461 limit (conducted or radiated) will be made, similar to that shown for broadband radiated interference in Figure 14. The effects of shielding on radiated emissions, as discussed in Section 4.0, will be shown in this plot. The steps of the mathematical analysis used will be shown on the graphic plot, on additional pages as necessary, and added to this control plan as part of a future revision.

7.4 **LINE FILTERS AND SUPPRESSION NETWORKS.** All types of lines such as power, signal, and control will be analyzed to determine the line filtering necessary to maintain the calculated value of shielding required for all enclosures, as discussed in Section 4.0, and to prevent undesired coupling between wiring and cables. An analysis of all RF leads, cables, and waveguides will also be made to determine the filter and suppression networks required to limit susceptibility to interference signals and limit the emission of undesired signals. The details of all the above analyses will be added to this control plan in a revision.

7.5 **SUPPLEMENTAL ANALYSES AND DESIGN DATA.** Specific interference analyses and control measures to be incorporated into the design of each subsystem unit are contained in Exhibit B to supplement the general requirements covered to this point in this Control Plan.

8.0 EMC TESTING.

8.1 FINAL TESTING. Final EMC testing to demonstrate compliance with the requirements of MIL-STD-461/462 will be carried out using three separate subsystem groups. Such subsystem grouping eliminates the necessity for elaborate simulated test loads and approaches the dynamic conditions of complete subsystem operation. The MIL-STD 461 tests that will be accomplished on Subsystem No. 1, consisting of Sensor Subsystem Group, Relay Subsystem Group, and Surface Terminal Subsystem Group are:

1. Power line conducted CE01, CE03 accomplished on aircraft/subsystem interface power leads.
2. Control lines conducted CE02, CE04 accomplished on Southwic subsystem or aircraft/subsystem interfaces.
3. Power line susceptibility CS01, CS02 accomplished on aircraft/subsystem interfaces.
4. Intermodulation, two signal rejection, cross modulation, CS03, CS04, and CS05 accomplished on all receivers in the subsystem.
5. Radiated emission RE02 accomplished on each subsystem group.
6. Induction field RS02 accomplished on each subsystem group.
7. Radiated susceptibility RS03 accomplished on each subsystem group.
8. Power line spike susceptibility, CS06 accomplished on aircraft/subsystem interface power leads.

8.1.1 Final Testing Considerations. The following considerations apply to final testing.

1. Each final acceptance test will use an interconnecting cable configuration similar to that of the actual cables to be used in the final installation.
2. Problems are expected in meeting the MIL-STD-461, CE01 test requirement. This results from the fact that input filters that perform reasonably well at frequencies as low as 30 Hz are large packages. Some design trade off is anticipated in this area, particularly in those power circuits that use AC input. In the case of AC (400 Hz) input circuits, present plans call for the use of a high pass filter in series with the interference detector input during CE01 tests. This high pass filter will reject all frequencies below the fifth harmonic of the power line frequency.
3. MIL-STD-461, CE05 tests will not be performed since this test is a variation in test technique only and duplicates other tests that will be performed. Further, since this test requires an impedance tracking filter if test results are to be accurate, it is an extremely poor test technique. If this test is deemed necessary, test costs will increase considerably since the inverse elements must be designed and calibrated with the actual circuits where they will be used.
4. MIL-STD-461, CS01, and CS02 test methods will be applied at those power input points that interface with primary and conditioned power. Modified levels will be used on conditioned power.

5. MIL-STD-461, (T) RE04 method will be applied to individual units but not to subsystem groups during final test phases.

6. MIL-STD-461, RE03 will be performed on equipments operating above 1.24 GHz.

8.2 DEVELOPMENTAL TESTING. Before the subsystem has been designed to the extent that it may be subjected to final EMC testing, developmental or breadboard test investigations may be made. This type of testing will be done on such circuits as conversion type power supplies, switching circuits, and other similar subcontractor supplied items of hardware. The necessity for these tests results from the fact that prediction analysis techniques are not always useful tools unless all circuit parameters are known in detail.

8.2.1 Specific Developmental Tests. In addition to the above general types of developmental tests, certain specific questions will require further testing in the laboratory as follows:

1. With a 300 watt TWTA output power level being fed to a common antenna, there is a question as to the degree of terminal isolation that can be achieved through the use of bandpass filters and circulators. Further, the effect of circulator input current variations upon signal quality is not a specifically known quantity at this time. Tests may be necessary to resolve these questions.

2. Frequency selection, as well as mode selection, is made by application of a 5 volt signal. Tests may be necessary to establish the definite "on" and "off" thresholds for these circuits.

3. Coaxial cable RF signal isolation (cable-to-cable), including terminating connectors, is not known at this time. It may be necessary to test mock-up configurations of various cables since these data are not available from either cable or connector manufacturers.

8.2.2 Additional Susceptibility Testing. In addition to testing each equipment at the levels called for in MIL-STD-461 susceptibility tests (CS- and RS- tests), tests at the following levels will also be made when feasible.

1. Test Signal 6 dB above MIL-STD-461 specified level for all conducted susceptibility (CS-) tests.

2. Radiated field of 10 volts/meter for radiated susceptibility test RS03.

3. The level at which analysis shows degradation of performance below specified limits will occur.

These tests will accomplish the following:

1. Validate accuracy of analyses and predictions.

2. Provide data for increasing the types and accuracy of analyses that can be made.

3. Indicate whether design criteria have been met or exceeded, and if exceeded, to what degree.

8.3 TEST PLAN. A test plan detailing the EMC testing program, as called for by MIL-STD-461A, will be prepared and submitted to Southwic in August of 1970 (see schedule in Figure 2).

8.4 TEST SCHEDULE. The performance of investigative tests during the equipment development period is not subject to schedule considerations other than those imposed by the demand for performance data prior to timely incorporation of any given item into the design. These tests are therefore accomplished as required. Final EMC subsystem acceptance testing, to demonstrate compliance with MIL-STD-461A and other contract EMC requirements, is scheduled for the month of January 1971 (Figure 2).

8.5 TEST REPORT. The test report will be written in accordance with paragraph 4.4 of MIL-STD-461A. If a problem or deficiency is uncovered during testing, it will be described in the report and be reported to the Duron systems engineer. The system engineer will ensure that the necessary corrective action is taken and described in the report. The report will also describe any problems left unsolved along with any suggestions and recommendations for solving them, such as methods of operation to avoid the problem(s). This test report will be submitted in March 1971 (Figure 2).

8.6 TEST FACILITIES. All EMC testing, both developmental and final acceptance testing, will be carried out at the Duron Corporation facilities in Sterling, Illinois.

8.6.1 Test Equipment. Although neither MIL-STD-461A nor MIL-STD-462 provides a complete list of test equipment to perform the required tests such a list is being compiled by Duron Corporation based on past experience with similar tests. Duron has the test equipment required for testing in the frequency range of 150 kHz to 1 GHz, except for some special antennas specified by MIL-STD-461A. Also, some test equipment must be acquired to cover testing in the frequency range of 1 GHz to 10 GHz. It is planned to purchase or lease all required items of test equipment that are not already at hand. It is anticipated that all such required items will be procured in time to permit preliminary developmental type testing and final acceptance testing. A complete list of test equipment to be used will be provided in a later revision of this Control Plan.

8.6.2 Shielded Rooms. The ambient interference level must be 6 dB below the conducted and radiated interference limits of MIL-STD-461A. This dictates the use of shielded enclosures and filtered power for operating the test sample as well as the test equipment. Steps are being taken to modify existing rooms to the necessary size.

EXHIBIT A

OF

APPENDIX B

TO

NAVAIR EMC EDUCATIONAL MANUAL

EMI CONTROL CHECKLIST

This exhibit contains the Duron EMI control checklist that all design engineers are required to use, with an example of a typical engineer's answers to the questions. This checklist is included for reference only.

EMI CONTROL CHECKLIST

EMC considerations	Engineer: Sam Jones
A. Circuits to be shielded and filtered.	
1. Have any of the following EMI producing circuits been filtered?	
a. Relays	Diodes
b. DC motors	Yes
c. Switches	Yes
d. Clock or timing circuits with fast rise time or high repetition rates	Yes
2. Have transformer-rectifier (TR) outputs been filtered; was the transformer electro-statically shielded?	Yes
3. Have any components with inherent shielding been used, such as cupreous tuning inductors?	Yes
4. What type of electromagnetic field is being shielded against, E field or H field?	E and H
Is the shielding material suitable for this type of field for the frequency range of interest?	Yes
5. Have decoupling capacitors been used on internal power connections?	Yes
6. Have any feedthrough or bypass capacitors been used for internal connection of circuits? Or as bulkhead-mounted headers?	Yes
7. Have shielded subassemblies been used in the equipment?	Yes
8. Have RF chokes and inductors been used to confine the RF energy to the desired circuits?	Yes
9. Were parts of internal chassis used to obtain shielding?	Yes
10. Have waveguide-below-cutoff techniques been used for chassis openings, such as tuning adjustments or air cooling?	Yes
11. Have low-level or susceptible circuits been physically separated from EMI-producing circuits within an enclosure?	Yes
12. Have toroids been used to minimize the leakage field of inductors? Have inductors been cross-oriented to minimize coupling?	No (Shielding is used)

EMI CONTROL CHECKLIST (CONT)

EMC considerations	Engineer: Sam Jones
B. Methods of eliminating spurious emanations and responses.	
1. Are components being operated in linear rather than non-linear regions, if possible?	Yes
2. Are crystal-controlled circuits being used? Has the best choice of multiplier stages been made?	N/A
3. Have crystal filters, bandpass filters, tank circuits, tuned stages, and other narrowband devices been used?	Yes
4. Have circuits been used which inherently discriminate against creation or passage of certain harmonics such as push-pull outputs of amplifiers, balanced mixer coupler combinations, and other hybrid circuits of a similar nature?	Yes
5. Have circuits of balanced or symmetrical design been used?	Yes
6. Have diodes or other biasing devices been used to establish minimum or maximum actuation levels for circuits?	Yes
7. Have coincidence circuits, time-delay circuits, or similar logic circuits been used?	Yes
8. Have circuits using coded inputs or outputs been used?	Yes
9. Has filtering been done at subsystem levels, especially multiplier stages?	Yes
10. Have RF circuits been decoupled from power supplies?	Yes
11. Have short lead lengths been used in RF circuits?	Yes
Has internal wire routing been controlled?	Yes
12. Have circuits potentially capable of producing or of being susceptible to spurious energy been physically and electrically isolated?	Yes
13. Are internal subassemblies shielded and filtered to prevent undesired modulation?	Yes
14. Have components and devices been chosen to minimize frequency drift or random modulation caused by temperature, aging, vibration?	Yes

EMI CONTROL CHECKLIST (CONT)

EMC considerations	Engineer: Sam Jones
15. Have operating frequencies been chosen to avoid conflicts with known existing frequencies or their harmonics?	Yes
16. Have the proper power levels of generated frequencies been used, such as the local oscillator stages of receivers or multiplier and output stages of transmitters?	Yes
17. Has circuitry (other than RF circuits of receivers and transmitters) such as power connections and monitoring points been controlled by preventing RF coupling to other circuits?	Yes
18. Have tuning methods that minimize modes or harmonic generation been used?	Yes
19. Have all feedback loops been designed to prevent oscillation under worst case conditions?	Yes
20. Have high-power and low-power stages of units been isolated?	Yes
21. Is the proposed enclosure bonding adequate at the known critical radio frequencies?	Yes
22. Have component tolerances been controlled to prevent frequency drift and mode switching caused by temperature and aging?	Yes
23. Have RF components been used throughout RF stages? That is, have components been used that are not self-resonant in the intended frequency range (unless desired)?	Yes
24. Have special circuits that discriminate against spurious resonance been used?	Yes
C. Methods of obtaining continuous shielding on equipment using pressure or hermetic seals.	
1. Has the enclosure been mechanically designed to assure sufficient pressure between mating parts?	Yes
2. Has each opening in any enclosures been analyzed to determine the need for gaskets, waveguide-below-cutoff techniques, screening?	Yes
3. Has the minimum attenuation needed by the enclosure been evaluated?	Yes

EMI CONTROL CHECKLIST (CONT)

EMC considerations	Engineer: Sam Jones
4. If dissimilar metals have been used in the enclosure, is this compatible with the expected environment?	Yes
5. If RF gaskets have been used, is the design adequate to optimum pressure, class of joint or seam, choice of gasket mounting, size of gasket, attenuation of gasket?	Yes
6. What are the expected internal and external fields and expected frequencies?	E Field 50 MHz
D. Selection of interference-free components to be used with other components.	
1. Are diodes being used across relay coils?	Yes
2. Are solid-state switches being used instead of mechanical switches?	Yes
3. Are separate connectors being used for sensitive and EMI-producing circuits?	Yes
4. Is twisted pair, twisted triad, or shielded wire being used?	Yes
5. Are connectors being used as inherent parts of filters?	Yes
6. Are crystals being used as frequency sources?	No
7. Are temperature-compensated components being used to minimize drift, etc.?	Yes
8. Are components being operated in linear regions?	Yes
9. Are limiting devices, such as diodes, being used?	Yes
10. Are DC blocking capacitors being used?	Yes
E. Other pertinent information.	
1. Are there any special type circuits that intentionally or unintentionally eliminate or minimize EMI? Examples might be blanking circuits, time-sequencing circuits, disabling circuits, bridge or differential type of circuits, balanced input circuits, possibly AGC, AFC, and AVC circuits.	Yes
F. A guide for connectors:	
1. Does connector shell have conductive finish?	Yes

EMI CONTROL CHECKLIST (CONT)

EMC considerations		Engineer: Sam Jones
2.	Are signal and power circuits routed in separate connectors?	Yes
3.	Have provisions been made for termination of shields?	Yes
4.	Have filter pins been incorporated where necessary?	Yes
5.	Have provisions been made for use of shielded (coaxial) pins for circuits that must have isolated continuous circuits?	Yes
6.	Has electrical continuity through the shell been verified during vibration tests?	Yes (by vendor)
7.	Have chassis or bulkhead mounted connectors been mounted by methods that ensure good electrical connection?	Yes

EXHIBIT B

OF

APPENDIX B

TO

NAVAIR EMC EDUCATIONAL MANUAL

SUPPLEMENTAL ANALYSES

AND

DESIGN DATA

This exhibit contains a separate section for each subsystem ι. ι Each of these sections is intended to serve as an EMI/EMC design reference for the equipment engineer assigned to the design function for each particular unit. This exhibit is included in this Control Plan as a means of avoiding oral EMI/EMC design guidance.

Section 1

Antenna Selector

1.0 GENERAL. This section sets forth the detailed interference control requirements for the antenna selector. This unit will be installed in both the sensor and relay aircraft. It contains diplexing circuitry which handles the C band data transmitter output and the C band receiver input. It also contains switching circuits which select between either of two antennas, upper and lower respectively.

1.1 The requirements contained in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification 5-15001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference generation and susceptibility characteristics within the limits of MIL-STDS-461/462. These requirements are in addition to the requirements contained in the main body of this Control Plan.

2.1 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan. Electrical connectors incorporating filter pins will not be used as they offer very little attenuation when used in relatively low impedance circuits.

2.2 CONTROL LEADS. Input control signal leads will be routed through an electrical connector in the manner described by the wiring matrix shown in Figure 6 of the Control Plan.

2.3 RF CONNECTORS. RF connectors will be bonded to the equipment enclosure as specified in Figure 7 of the Control Plan..

2.4 CABLE AND SIGNAL SEPARATION. Specific cable and signal separation requirements are set forth in paragraph 5.0.

2.5 UPPER-LOWER ANTENNA, SAMPLER DRIVE. The antenna selector is switched between the upper and lower antennas at a sampling rate of 50 Hz. This signal consists of a square pulse at a voltage level of 5 volts. This signal is not always provided subsequent to acquisition. It must be maintained however within the radiated limits specified in MIL-STD-461. A graphic analysis of pulse amplitude vs frequency dispersion will be performed.

2.6 SWITCHING CIRCUITRY. The antenna selector contains certain switching circuitry that will be analyzed to determine the interference generation characteristics. When this has been done in a manner similar to 2.5 above, these data will be used to develop adequate control or containment of generated EMI.

3.0 MECHANICAL DESIGN REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of the Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control monitoring will be accomplished to ensure adequacy of design in accordance with accepted and required EMI control practices. In the event questionable aspects become evident as a result of this monitoring effort and cannot be resolved, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 2

C Band Directional Antenna

1.0 GENERAL. This section contains the discussion of detailed interference control requirements for the C band, directional antenna assembly. This antenna assembly will be installed in both the relay and sensor aircraft. These antennas are installed on the top and bottom of the aircraft and are used to receive and transmit C band signals. The antenna assemblies are provided with the necessary circuitry to azimuth track throughout 360°

1.1 All of the requirements set forth in this section are designed to comply with MIL-STDS-461/462 as specified in Southwic Specification 5-16001.

2.0 ELECTRICAL DESIGN REQUIREMENTS. The following design requirements will be incorporated as an integral part of the basic equipment. These requirements are considered the basic minimums for control of interference generation and susceptibility characteristics.

2.1 ELECTRICAL CONNECTORS. All electrical connectors will be bonded to the equipment housing in accordance with the typical techniques shown in Figure 7 of the Control Plan.

2.2 CABLE SEPARATION. Power, signal (reference), and control leads will be routed through separate electrical connectors if possible. The exact input/output configuration of all these leads will be included in the connector/wiring matrix. Figure 6 of the Control Plan.

2.3 RF CONNECTORS. RF connector types will be determined by the degree of isolation required. Installation techniques for the type of connectors used will conform with the general configuration shown in Figure 7 of the Control Plan.

2.4 INPUT POWER. Input power to the antenna assembly is 115 volts, 400 hz and 28 VDC. The loads will be thoroughly analyzed to determine the interference envelope. These analyses will be made to determine whether or not a need exists for input power line filters or if line twisting or shielding is permissible.

2.5 SWITCHING. All switching functions within the antenna assembly will be performed by solid state switches. No relay switching is anticipated at this time. Since there are inductive loads involved in the switching scheme, an analysis will be made to ensure that the assembly housing and any filters used will keep the resultant interference levels within acceptable limits.

2.5.1 There is one mechanical switch function located in the 28 VDC circuit. The switched output provides an indication signal to the antenna control unit. Therefore, there is a possibility that this interconnection may need to be decoupled with a line filter. Filter requirements will be analyzed in accordance with Paragraph 6.0 of the Control Plan.

2.6 ANALOG SIGNALS. Synchro signals are routed between the antenna assembly and the antenna control unit. These signals will be routed via twisted and shielded triad cables to eliminate undesirable coupling of extraneous signals.

3.0 MECHANICAL DESIGN REQUIREMENTS. Paragraph 4.0 of the Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control monitoring will be accomplished to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring effort and resolution cannot be accomplished, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in st ct consonance with the requirements of this Control Plan.

Section 3

Antenna Control Unit

1.0 GENERAL. This section contains EMI control design requirements for the antenna control unit. This antenna control unit will enable the aircraft antennas to search for, acquire, and automatically track in azimuth the source of coded RF transmissions.

1.1 The requirements contained in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification 5-21001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference generation and susceptibility characteristics within the limits of MIL-STDS-461/462.

2.1 BUILD-IN TEST EQUIPMENT (BITE). The BITE circuitry incorporated into the antenna control unit will be designed to meet the requirements of MIL-STD-461/462. This circuitry is used during the operational mode to monitor various functions in the antenna control unit under tactical conditions. In the test mode, locally generated signals are used in the antenna control unit to simulate signals fed to the antenna control unit so that the unit can be tested. Every precaution will be taken to reduce undesirable interference generation and minimize or eliminate any possible susceptibility to extraneous fields during normal operation and in the test mode.

2.2 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure in the manner shown in Figure 7 of the Control Plan. Electrical connectors incorporating filter pins will not be used as they offer very little attenuation when used in relatively low impedance circuits.

2.3 RF CONNECTORS. Panel type RF connectors will be bonded to the equipment enclosure as specified in Figure 7 of the Control Plan. Other types of RF connectors will be bonded to the airframe or equipment chassis at every point where they interrupt the overall coaxial system.

2.4 INPUT POWER. Input power is considered a primary interface. Interference decoupling networks will be located as required adjacent to the input power connector. The performance requirements for these networks will be based upon detailed mathematical analysis of interference sources performed in accordance with the techniques contained in previous paragraphs of this Control Plan. Filter networks installed within AC input leads will be designed to withstand the transient voltage requirements specified in MIL-STD-704, Category B.

2.4.1 In no case will shielded cable be used in a primary power input circuit. All power input leads will be routed as twisted pairs, triads, or quads depending upon the type of power. The neutral will be routed with the power high leads and will be grounded as discussed in paragraph 6.3 of the Control Plan.

2.5 INPUT SIGNAL CHARACTERISTICS. The antenna control unit will accept the following input signals:

1. AGC Signal: Since this is a slowly varying DC voltage, there will be no EMI generation problems associated with it. This signal will be routed on twisted pair cable owing to susceptibility characteristics.
2. Antenna Tracking Error Signal: This is essentially a 500 Hz AC signal. This signal will not produce significant EMI levels. Analysis of susceptibility characteristics will be made to determine possible requirements for shielding.
3. Manual/Auto Select: This is an operator control signal function and will establish whether the upper-lower antenna is automatically selected or manually selected by the operator. When this control is switched from manual to auto the resulting step function will generate EMI levels in excess of the applicable radiated and conducted specification limits. Since the exact RF nature of this signal is complex, a graphic presentation of the spectral frequency/amplitude envelope for both the possible radiated and conducted interference levels will be developed.
4. Manual Azimuth Control Signal: This is an operator control function and provides for manual positioning in azimuth of the antennas. The EMI characteristics of this control signal will be the same as those described in Paragraph 2.5 (3) above.
5. Rate Feedback: This signal is derived from the antenna tachometer. The possible EMI levels both for generated and susceptibility aspects will be analyzed.
6. Aircraft Attitude Signals: The aircraft roll, pitch, and heading servo signals are to be routed from point to point through shielded twisted triad cables. Since these are analog, no EMI is expected, although no EMI test data on the source equipment is available. Care will be taken to preclude susceptibility problems.
7. Antenna Azimuth Position: This signal is the feedback signal from the antenna synchro. It is to be routed from point to point through shielded twisted triad cables.

2.6 OUTPUT SIGNAL CHARACTERISTICS. The antenna control unit output signal characteristics will be as follows:

1. Antenna Motor Drive Voltage: This output will be 115 VAC, 400 Hz. The motor drive voltages will be routed from point to point through shielded twisted leads.
2. Monopulse Sampler Drive Signal: This is a 500 Hz square wave. It is expected that this signal will be a source of EMI. However the amplitude and rise time of the signal will be determined before the EMI analysis is completed. A graphic presentation of the spectral frequency/amplitude envelope for both the possible radiated and conducted interference levels will be developed for use by the equipment designer.
3. Upper-Lower Antenna Sampler Drive Signal: This signal is a 500 Hz square wave. The expected EMI characteristics of this signal are similar to those described for the monopulse drive signal, Paragraph 2.6 (2) above.
4. Antenna Azimuth Indication: This is essentially an analog signal. This signal will be routed from point to point through shielded twisted triad cables to eliminate susceptibility problems.
5. Link-Lock Indication: This is a GO/NO-GO signal. The voltage levels are 0 V + 0.5 V, and 4.5 ±0.5V The shape of the EMI envelope produced from this step function is dependent upon whether the function is derived from a solid state or a mechanical source. A graphic presentation of the spectral frequency/amplitude envelope for both the possible radiated and conducted interference will be developed as the source circuitry is specified.
6. Antenna Selection: The nature of this output may result in EMI problems. The EMI characteristics of the antenna selection signals will be analyzed and plotted for use by the equipment designer.

3.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of the Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure periodic EMI control monitoring will be accomplished to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring effort and cannot be resolved, tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 4

C Band Data Transmitter

.1.0 GENERAL. This section contains the interference control design requirements for the C band data transmitter. This transmitter will be installed in the sensor aircraft and is used to generate and transmit a beacon signal during acquisition. It is also used during the operational mode to accept either a digital signal or wideband sensor signals. The transmitter translates these signals into any one of five C band data channels and further amplifies the signals to a power output level of 250 watts.

1.1 The requirements in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification S-22001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference generation and susceptibility characteristics within the limits of MIL-STDS-461/462.

2.1 BUILT-IN TEST EQUIPMENT (BITE). The BITE circuitry incorporated into the C band data transmitter will be designed to meet the requirements of MIL-STD-461/462. This circuitry is used during the operational mode to monitor the operation of the C band data transmitter under tactical conditions. In the test mode, a locally generated modulation signal is used to test the C band data transmitter. Every precaution will be taken to reduce undesirable interference generation and minimize or eliminate any possible susceptibility to extraneous fields during normal operation and in the test mode.

2.2 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure as shown in Figure 7. Electrical connectors incorporating filter pins will not be used as they offer very little attenuation when used in relatively low impedance circuits.

2.2.1 Input power and signal leads will not be mixed by routing through a common electrical connector. Signal and power leads will be separated in accordance with data provided in the cable matrix shown in Figure 6 of the Control Plan.

2.3 RF CONNECTORS. Panel type RF connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan. In addition, other types of RF connectors will be bonded to the airframe or equipment chassis at every point where they interrupt the overall coaxial system.

2.4 INPUT POWER. Input power will be considered a primary interface. Interference decoupling networks as required will be located adjacent to the input power connector. The performance requirements for these networks will be based upon detailed mathematical analysis of interference sources performed in accordance with the techniques contained in previous paragraphs of this Control Plan. Filter networks installed within AC input leads will be designed to withstand the transient voltage requirements specified in MIL-STD-704, Category B.

2.4.1 In no case will shielded cable be used in a primary power input circuit. All power input leads will be routed as twisted pairs, triads, or quads depending upon the type of power. The neutral will be routed with the power high leads and grounded as discussed in Paragraph 6.3 of the Control Plan.

2.5 TRANSMITTER INPUTS. The transmitter accepts wideband sensor data, digital data stream, and auxiliary data inputs. Many of these signals occupy a wide frequency spectrum, therefore, they are potential interference sources. When min./max. repetition rates, rise/fall times and amplitude are known, a graphic analysis will be made of these signals. These detailed analyses of frequency/amplitude interference profiles will be used by the equipment designer to develop EMI control circuits and techniques.

2.6 OUTPUT SIGNAL CHARACTERISTICS. The transmitter spurious output will be controlled within the limits of MIL-STD-461 (CE 06) through the use of a bandpass filter. Stopband and passband performance of this filter will be developed in conjunction with output circuit characteristics.

2.7 CONTROL SIGNAL NOISE ENVELOPE. The data transmitter is controlled by remote inputs which serve to select the desired transmission channel. The maximum voltage of this control signal is 4.5 volts. Since this level borders on an "out of spec" radiated condition, an analysis of the amplitude/frequency spectrum will be made and included in this Plan by later revision.

2.8 CHANNEL OVERLAP. Channel overlap envelope data will be developed to evaluate possible EMC problems under tactical conditions. These data will also serve to advantage during MIL-STDS-461/462 tests, and therefore will be provided to the equipment test engineer.

3.0 MECHANICAL DESIGN REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of the Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control monitoring will be accomplished to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring effort and cannot be resolved, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 5

C Band Beacon Receiver

1.0 GENERAL. This section contains EMI control design requirements for the C band beacon receiver. This receiver will be installed in the sensor aircraft and will receive a FSK modulated and amplitude modulated C band beacon signal for mission identification and system status.

1.1 The requirements contained in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification 5-23001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference generation and susceptibility characteristics within the limits of MIL-STD-461/462.

2.1 BUILT-IN TEST EQUIPMENT (BITE). The BITE circuitry incorporated into the C band beacon receiver will be designed to meet the requirements of MIL-STD-461/462. This circuitry is used during the operation mode to monitor the operation of the C band beacon receiver under tactical conditions. In the test mode, a locally generated signal is used to test the C band beacon receiver. Every precaution will be taken to reduce undesirable interference generation and minimize or eliminate any possible susceptibility to extraneous fields during normal operation and the test mode.

2.2 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan. Electrical connectors incorporating filter pins will not be used as they offer very little attenuation when used in relatively low impedance circuits.

2.2.1 Input power and signal leads will not be mixed by routing through a common electrical connector. Separation of signal and power leads will be accomplished in accordance with data provided in the cable matrix which is shown in Figure 6 of the Control Plan.

2.3 RF CONNECTORS. Panel type RF connectors will be bonded to the equipment enclosure as specified in Figure 7 of the Control Plan. In addition, other types of RF connectors will be bonded to the airframe or equipment chassis at every point where they interrupt the overall coaxial system.

2.4 INPUT POWER. Input power will be considered a primary interface. Interference decoupling networks as required will be located adjacent to the input power connector. The performance requirements for these networks will be based upon detailed mathematical analysis of interference sources performed in accordance with the techniques contained in previous paragraphs of this Control Plan.

2.4.1 In no case will shielded cable be used in a primary power input circuit. All power input leads will be routed as twisted pairs, triads, and quads depending upon the type of power. The neutral will be routed with the power high leads and grounded as discussed in Paragraph 6.3 of the Control Plan.

2.5 CONTROL SIGNAL INPUT. The C band beacon receiver will be controlled by remote inputs to select the desired operating channel. This signal is 4.5 volts maximum across 1000 ohms minimum. A graphic presentation of the spectral frequency/amplitude envelope for the radiated interference resulting from the control signal will be included later as a revision of this Control Plan.

2.6 DIGITAL BEACON SIGNAL OUTPUT. The beacon receiver demodulates the serial digital data contained on the beacon RF signal in the FSK information and provides a serial bit stream output with the following characteristics: maximum level 5 volts across 500 ohms, keying rate of 20 kbps maximum. A graphic presentation of the spectral frequency/amplitude envelope for both the radiated and conducted interference resulting from the bit stream will be developed for use by the equipment designer.

2.7 AGC OUTPUT. The receiver provides this signal of 0 to 5 volts DC proprotional to the RF input level to the receiver. When signal is abruptly acquired or lost, the resulting spectral frequency/amplitude envelope may vary as a step function, therefore an analysis of this condition will be made.

2.8 ANTENNA TRACKING ERROR SIGNAL. This is essentially a 500 Hz signal. This signal will not produce significant EMI levels.

3.0 MECHANICAL DESIGN REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of the EMI Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control will be monitored to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring effort and cannot be resolved, investigative tests will be performed upon breadborad models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 6

Ku-Band Directional Antenna Assembly

1.0 GENERAL. This section contains EMI control design requirements for the directional Ku-band antenna assembly. This antenna shall employ monopulse techniques to track a coded beacon signal provided by the surface terminal. The antenna shall search, acquire, and lock on to the desired beacon signal. Once lock-on is completed, data transmittal may begin.

1.1 The requirements contained in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification 5-30001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference generation and susceptibility characteristics within the limits of MIL-STDS-461/462.

2.1 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan. Electrical connectors incorporating filter pins will not be used as they offer very little attenuation when used in relatively low impedance circuits.

2.1.1 Input power and signal leads will not be mixed by routing through a common electrical connector. Signal and power leads will be separated in accordance with data provided in the cable matrix shown in Figure 6 and as discussed in Control Plan Paragraph 5.5.

2.2 RF CONNECTORS. Panel type RF connectors will be bonded to the airframe or equipment chassis at every point where they interrupt the overall coaxial system. See Figure 7 of the Control Plan for typical means of bonding and grounding.

2.3 INPUT POWER. Input power will be considered a primary interference. Interference decoupling networks as required will be located adjacent to the input power connector. The performance requirements for these networks will be based upon detailed mathematical analysis of interference sources performed in accordance with the techniques contained in previous paragraphs of this Control Plan. Filter networks installed within AC input leads will be designed to withstand the transient voltage requirements specified in MIL-STD-704, Category B.

2.3.1 In no case will shielded cable be used in a primary power input circuit. All power input leads will be routed as twisted pairs, triads, or quads depending upon the type of power. The neutral will be routed with the power high leads and grounded as discussed in Paragraph 6.4 of this Control Plan.

2.4 INPUT SIGNAL CHARACTERISTICS. The input signals and their characteristics are as follows:

1. Data Signal: This is an RF signal from the Ku-band transmitter. Exact frequency is given in Classified Section of 5-02001. This will obviously be a coaxially interconnected signal. If more exact analysis is required, it will be included in a classified appendix.
2. Monopulse Sampler Driver Signal: This is a 500 Hz square wave. Prediction of the EMI envelope is dependent upon the amplitude and rise time of the signal. A graphic presentation of the spectral frequency/amplitude envelope for both the possible radiated and conducted interference resulting from the drive signal will be made to aid the equipment design engineer.
3. Servo Motor Drive Signal Shielded twisted triad cable will be used to route this signal.
4. Beamwidth Control: This is a control voltage of 5 volts. Prediction of the EMI envelope is dependent upon knowledge of the rise time and frequency of the signal. It is also necessary to know whether the signal is from a mechanical or a solid state source. EMI will be analyzed as the above determinations are made.
5. Synchro Reference Voltage: This signal will be routed via shielded twisted triad cable.

2.5 OUTOUT SIGNAL CHARACTERISTICS. The output signals and their characteristics are as follows:

1. Rate Feedback Voltage: The shielding requirements consist of shielded pair, balanced circuitry.
2. Antenna Azimuth Position: The control requirements consist of shielded triad, balanced to neutral.

3.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of the EMI Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control will be monitored to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring and cannot be resolved, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 7

Ku-Band Omni Antenna Assembly

1.0 GENERAL. This section contains EMI control design requirements for the Ku-band omni antenna assembly, Southwic Specification 5-31007 This antenna will be installed in the relay aircraft and will transmit an omnidirectional Ku-band RF signal to the surface terminal.

1.1 Due to the passive nature of the antenna assembly, this section contains no requirements for EMI control except for electrical bonding and grounding.

2.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. See Paragraph 4.0 of the Control Plan, which details all basic mechanical construction requirements.

Section 8

Ku-Band Beacon Receiver

1.0 GENERAL. This section contains EMI control design requirements for the Ku-band beacon receiver. This receiver will be installed in the relay aircraft to receive a coded FM signal in the Ku-band region.

1.1 The requirements in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification 5-32001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference generation and susceptibility characteristics within the limits of MIL-STDS-461/462.

2.1 BUILT-IN TEST EQUIPMENT (BITE). The BITE circuitry incorporated into the Ku-band beacon receiver will be designed to meet the requirement of MIL-STDS-461/462. This circuitry is used during the operational mode to monitor the operation of the Ku-band beacon receiver under tactical conditions. In the test mode, a locally generated signal is used to test the C band beacon receiver. Every precaution will be taken to reduce undesirable interference generated and minimize or eliminate any possible susceptibility to extraneous fields during normal operation and in the test mode.

2.2 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan. Electrical connectors incorporating filter pins will not be used as they offer very little attenuation in relatively low impedance circuits.

2.2.1 Input power and signal leads will not be mixed by routing through a common electrical connector. Signal and power leads will be separated in accordance with data provided in the cable matrix (Figure 6) and as discussed in Paragraph 5.5 of the Control Plan.

2.3 RF CONNECTORS. Panel type RF connectors will be bonded to the equipment enclosure as specified in Figure 7 of the Control Plan. Other types of RF connectors will be bonded to the airframe or equipment chassis at every point where they interrupt the overall coaxial system.

2.4 INPUT POWER. Input power will be considered a primary interface. Interference decoupling networks as required will be located adjacent to the input power connector. The performance requirements for these networks will be based upon detailed mathematical analyses of interference sources performed in accordance with the techniques contained in previous paragraphs of this Control Plan.

2.4.1 In no case will shielded cable be used in a primary power input circuit. All power input leads will be routed as twisted pairs, triads, or quads, depending upon the type of power. The neutral will be routed with the power high leads and grounded as specified in Paragraph 6.3 of this Plan.

2.5 CONTROL SIGNAL INPUT. The Ku-band beacon receiver will be controlled by remote inputs to select the desired operating channel. This signal is 4.5 volts maximum across 1000 ohms minimum. A graphic presentation of the spectral frequency/amplitude envelope for both the radiated and conducted interference resulting from the control signals will be provided to the equipment designer to guide his EMI control effort.

2.6 DIGITAL BEACON SIGNAL OUTPUT. The beacon receiver demodulates the serial digital data contained on the beacon RF signal in the FSK information and provides a serial bit stream output with the following characteristics: maximum level 5 volts across 500 ohms, keying rate of 20 kbps maximum. A graphic presentation of the spectral frequency/amplitude envelope for both the radiated and conducted interference resulting from the bit stream will be calculated to aid the equipment designer in his EMI control effort.

2.7 AGC OUTPUT AND SIGNAL LEVEL MONITOR OUTPUT. The receiver provides these two identical signals of 0 to 5 volts DC proportional to the RF input level to the receiver. When signal is abruptly acquired or lost, the resulting spectral frequency/amplitude envelope may result in broadband generation. This condition will be analyzed for purposes of broadband control.

3.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of the Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control will be monitored to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring effort and cannot be resolved, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 9

C Band Beacon Transmitter

1.0 GENERAL. This section contains EMI control design requirements for the C band beacon transmitter. This transmitter will be installed in the relay aircraft and the surface terminal to provide a digitally coded C band beacon signal for use in automatic identification, lock-on, and tracking by a remote antenna.

1.1 The requirements contained in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification 5-34001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference generation and susceptibility characteristics within the limits of MIL-STDS-461/462.

2.1 BUILT-IN TEST EQUIPMENT (BITE). The BITE circuitry incorporated into the C band beacon transmitter will be designed to meet the requirements of MIL-STDS-461/462. This circuitry is used during the operational mode to monitor the operation of the C band beacon transmitter tactical conditions. In the test mode, a locally generated modulation signal is used to test the C band beacon transmitter. Every precaution will be taken to reduce undesirable interference generation and minimize or eliminate any possible susceptibility to extraneous fields during normal operation and in the test mode.

2.2 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan. Electrical connectors incorporating filter pins will not be used as they offer very little attenuation in relatively low impedance circuits.

2.2.1 Input power and signal leads will not be mixed by routing through a common electrical connector. Signal and power leads will be separated in accordance with data provided in the cable matrix table, Figure 6, as specified in Control Plan Paragraph 5.9.

2.3 RF CONNECTORS. Panel type RF connectors will be bonded to the equipment enclosure in the manner specified in Figure 7 of the Control Plan. Other types of RF connectors will be bonded to the airframe or equipment chassis at every point where they interrupt the overall coaxial system.

2.4 INPUT POWER. Input power will be considered a primary interface. Interference decoupling networks as required will be located adjacent to the input power connector. The performance requirements for these methods will be based upon detailed mathematical analysis of interference sources performed in accordance with the techniques contained in previous paragraphs of this Control Plan. Filter networks installed within AC input leads will be designed to withstand the transient voltage requirements specified in MIL-STD-704, Category B.

2.4.1 In no case will shielded cable be used in a primary power input circuit. All power input leads will be routed as twisted pairs, triads, or quads, depending upon the type of power. The neutral will be routed with the power high leads and grounded as specified in Paragraph 6.3 of the Control Plan.

2.5 BEACON DIGITAL SIGNAL INPUT. The C band beacon transmitter requires an input keying signal, which consists of a 5 volt (max.) pulse with a rise and fall time of 5 μsec maximum and a maximum keying rate of 20 kbps. A spectral presentation of this pulse showing noise amplitude vs frequency will be developed for use in EMI control. Since the keying rate is variable, and rise and fall times can be less than 5 μsec, the graphical presentation will be developed for the worst case combination.

2.6 CONTROL SIGNAL INPUT. The C band beacon transmitter will be controlled by remote inputs to select the desired operating channel. This signal is 4.5 volts maximum across 1000 ohms minimum. A graphic presentation of the spectral frequency/amplitude envelope for both the radiated and conducted interference resulting from the control signals will be developed for EMI control.

2.7 OUTPUT SIGNAL. The C band beacon transmitter spurious output will be controlled within the limits of CE 06 of MIL-STDS-461/462. Spurious outputs will be attenuated by a band pass filter which will reduce spurs to at least 90 dB down ±75 MHz about the center frequency and at least 60 dB down 100 to 800 MHz from the center frequency.

3.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of the Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control monitoring will be accomplished to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring effort and cannot be resolved, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 10

Ku-Band Data Transmitter

1.0 GENERAL. This section contains EMI control design requirements of the Ku-band data transmitter. The transmitter consists of an up-converter and a power amplifier WRA and will be used on the relay aircraft. If will receive a low-level UHF signal from the receiver and convert this signal to one of five selectable high power level Ku-band signals.

1.1 The requirements contained in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification 5-25001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference generation and susceptibility characteristics within the limits of MIL-STDS-461/462.

2.1 BUILT-IN TEST EQUIPMENT (BITE). The BITE circuitry incorporated into Ku-band data transmitter will be designed to meet the requirements of MIL-STDS-461/462. This circuitry is used during the operational mode to monitor the operation of the Ku-band data transmitter under tactical conditions. In the test mode, a locally generated modulation signal is used to test the Ku-band data transmitter. Every precaution will be taken to reduce undesirable interference generation and minimize or eliminate possible susceptibility to extraneous fields during normal operation and in the test mode.

2.2 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan. Electrical connectors incorporating filter pins will not be used as they offer very little attenuation in relatively low inpedance circuits.

2.2.1 Input power and signal leads will not be mixed by routing through a common electrical connector. Signal and power leads will be separated in accordance with data provided in the cable matrix shown in Figure 6 and as specified in Paragraph 5.5 of the Control Plan.

2.3 RF CONNECTORS. Panel type RF connectors will be bonded to the equipment enclosure as specified in Figure 7 of the Control Plan. Other types of RF connectors will be bonded to the airframe or equipment chassis at every point where they interrupt the overall coaxial system.

2.4 INPUT POWER. Input power will be considered a primary interface. Interference decoupling networks as required will be located adjacent ot the input power connector. The performance requirements for these networks will be based upon detailed mathematical analysis of interference sources performed in accordance with the techniques contained in previous paragraphs of this Control Plan. Filter networks installed within AC input leads will be designed to withstand the transient voltage requirements specified in MIL-STD-704, Category B.

2.4.1 In no case will shielded cable be used in a primary power input circuit. All power input leads will be routed as twisted pairs, triads, or quads, depending upon the type of power. The neutral will be routed with the power high leads and grounded in accordance with the requirements set forth in Paragraph 6.3.of this Control Plan.

2.5 INPUT SIGNAL CHARACTERISTICS. The Ku-band data transmitter will accept the following input signals:

1. RF Input Signal: The transmitter receives the 1370 MHz IF signal from the C band IF data receiver. The power level of this IF signal is +12 dBm minimum (50 ohms). The IF signal is to be routed through with type TNC connectors. The Ku-band data transmitter accepts either a digitally FSK modulated beacon acquisition signal or a PSK modulated signal from the C band data receiver. These signals occupy a wide frequency spectrum, therefore they are potential interference sources. When min./max. repetition rates, rise/fall times, and amplitude are known, a graphic analysis will be completed. These detailed analyses of frequency/amplitude interference profiles will be developed as an EMI control aid for the equipment designer.
2. Control Inputs/Control Signal Noise Envelope. The data transmitter is controlled by remote inputs which serve to select the desired transmission channel. The maximum voltage of this control signal is 4.5 volts. Since this level borders on an "out of spec" radiated condition, the analysis of the amplitude/frequency spectrum will be made and presented graphically in a later revision of this Control Plan.

2.6 OUTPUT SIGNAL CHARACTERISTICS. The transmitter spurious output will be controlled within the limits of MIL-STDS-461/462 (RE 03) through the use of a bandpass filter. Stopband and passband performance of this filter will be incorporated into the governing subcontractor procurement specifications.

2.6.1 Channel Overlap. Channel overlap envelope data will be developed to evaluate possible EMC problems under tactical conditions. These data also serve to advantage during MIL-STDS-461/462 tests. These data will be provided to the EMI test engineer as a test point guide.

3.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of the Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control will be monitored to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring effort and cannot be resolved, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 11

C Band Data Receiver

1.0 GENERAL. This section contains the interference control design requirements for the C band data receiver. This receiver shall be mounted in the relay aircraft. The receiver will receive wideband data signals transmitted by a reconnaissance aircraft (sensor aircraft), for retransmission by the relay system at Ku-band. The receiver also detects error signals which are used in positioning the receiver directional antennas.

1.1 The requirements contained in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification 5-36001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference generation and susceptibility characteristics within the limits of MIL-STDS-461/462.

2.1 BUILT-IN TEST EQUIPMENT (BITE). The BITE circuitry incorporated into the C band data receiver will be designed to meet the requirements of MIL-STDS-461/462. This circuitry is used during the operational mode to monitor the operation of the C band data receiver under tactical conditions. In the test mode, a locally generated signal is used to test the C band data receiver. Every precaution will be taken to reduce undesirable interference generation and minimize or eliminate any possible susceptibility to extraneous fields during normal operation and in the test mode.

2.2 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan. Electrical connecters incorporating filter pins will not be used as they offer very little attenuation in relatively low impedance circuits.

2.2.1 Input power and signal leads will not be mixed by routing through a common electrical connector. Signal and power leads will be separated in accordance with data provided in a cable matrix as shown in Figure 6 of the EMI Control Plan and as specified in Paragraph 5.5 of this Control Plan.

2.3 RF CONNECTORS. Panel type RF connectors will be bonded to the equipment enclosure in the manner specified in Figure 7 of the Control Plan. Other types of RF connectors will be bonded to the airframe or equipment chassis at every point where they interrupt the overall coaxial system.

2.4 INPUT POWER. Input power will be considered a primary interference. Interference decoupling networks as required will be located adjacent to the input power connector. The performance requirements for these networks will be based upon detailed mathematical analysis of interference sources performed in accordance with the techniques contained in Paragraph 6.3 of this Control Plan. Filter networks installed within AC input leads will be designed to withstand the transient voltage requirements specified in MIL-STD-704, Category B.

2.4.1 In no case will shielded cable be used in a primary power input circuit. All power input leads will be routed as twisted pairs, triads, or quads, depending upon the type of power. The neutral will be routed with the power high leads and grounded as specified in Paragraph 6.3 of this Control Plan.

2.5 INPUT SIGNAL CHARACTERISTICS. The C band data receiver will receive the following input signals:

1. Digital Data Transmission Signal: This is a quadriphase keyed digital signal. When exact frequency and amplitude are known, a graphic analysis will be made. Since this is essentially a low power level, no EMI problems are anticipated. Case will also be taken to preclude possible susceptibility problems.
2. Digital Beacon Transmission Signal: This is a FSK variable rate digital signal. The EMI characteristics of this signal are essentially the same as those described in Paragraph 2.5 (1) above.
3. Beacon Signal Generator Input: The input to the beacon signal generator portion of the receiver shall consist of the beacon encoder serial bit stream. This is a 0.5 to 5.0 volt NRZ digital stream. Rise/fall time is 5 microseconds maximum. Keying is variable 20 kHz maximum. A graphic presentation of the spectral frequency/amplitude envelope for both the possible radiated and conducted interference levels will be developed for use in EMI control by the equipment designer.
4. Wideband Sensor Signals. This is a DSBSC AM signal. The EMI characteristics of this signal are essentially the same as those described in Paragraph 2.5 (1) above.
5. Control Signal Noise Envelope. The data receiver is controlled by remote inputs which serve to select the desired channel, bandwidth, and operating mode. The maximum voltage of these control signals is 4.5 volts. Since this level borders on an "out of spec" radiated condition, a graphic presentation of the spectral frequency/amplitude envelope for the possible radiated interference levels will be prepared and added to this Control Plan in a future revision.
6. BITE Input. A C band beacon signal shall be supplied from the C band beacon transmitter for use in developing a BITE test signal within the C band receiver. When the amplitude of this signal becomes known, a graphic analysis of the possible interference envelope will be completed and used as the justification for implementation of EMI control measures.

2.6 OUTPUT SIGNAL CHARACTERISTICS. The C band data receiver will supply the following outputs. The data and beacon IF outputs are from the same output connector.

1. Data and Beacon IF Outputs. These are 1370 MHz IF output signals. The signal levels are a minimum of +12 dBm (50 ohms). The bandwidth of the data IF output is selectable from 18 to 110 MHz. The bandwidth of the beacon IF output is 100 kHz. These are considered susceptible and will be routed via coaxial cable.
2. Digital Beacon Signal Output. A demodulated beacon signal shall be developed in the FSK demodulator. This output is supplied to key the C band beacon transmitter. This signal consists of a 5 volts (max.) pulse with a rise and fall time of 5 μsec. maximum and maximum keying rate of 20 kbps. A spectral presentation of this pulse showing noise amplitude vs frequency will be developed for use in determining EMI control measures. Since the keying rate is variable and rise and fall times can be less than 5 μsec, the graphic analysis will be made for the worst case.
3. Antenna Tracking Error Signal. This is essentially a 500 Hz AC signal. This signal will not produce significant EMI levels, but owing to possible susceptibility, will be handled as a shielded, balanced circuit.
4. AGC Output Signal: This is a slowly varying DC signal. This signal will not produce significant EMI levels except under condition of immediate loss or acquisition of signal. Since this can result in a step function, this worst condition will be analyzed as a possible broadband source. Control measures will be based upon this worst case analysis.

3.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of the Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control will be monitored to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring effort and cannot be resolved, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 12

Ku-Band Beacon Transmitter

1.0 GENERAL. This section contains EMI control design requirements for the Ku-band beacon transmitter, This transmitter will be installed in the surface antenna terminals and is used to produce a Ku-band beacon signal. This signal provides a means of automatic identification and lock-on for tracking by a remote antenna.

1.1 The requirements contained in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification 5-41001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference generation and susceptibility characteristics within the limits of MIL-STDS-461/462.

2.1 BUILT-IN TEST EQUIPMENT (BITE). The BITE circuitry incorporated into the Ku-band beacon transmitter will be designed to meet the requirements of MIL-STDS-461/462. This circuitry is used during the operational mode to monitor the operation of the Ku-band beacon transmitter under tactical conditions. In the test mode, a locally generated modulation signal is used to test the Ku-band beacon transmitter. Every precaution will be taken to reduce undesirable interference generation and minimize or eliminate any possible susceptibility to extraneous fields during normal operation and in the test mode.

2.2 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan. Electrical connectors of the type which incorporate filter pins will not be used as these connectors offer very little attenuation in relatively low impedance circuits.

2.2.1 Input power and signal leads will not be mixed by routing through a common electrical connector. Signal and power leads will be separated in accordance with data provided in the cable matrix as shown in Figure 6 of the EMI Control Plan and as specified in Paragraph 5.5 of this Control Plan.

2.3 RF CONNECTORS. Panel type RF connectors will be bonded to the equipment enclosure as specified in Figure 7 of the Control Plan. Other types of RF connectors will be bonded to the airframe or the equipment chassis at every point where they interrupt the overall coaxial system.

2.4 INPUT POWER. Input power is considered a primary interface. Interference decoupling networks as required will be located adjacent to the input power connector. The performance requirements for these networks will be based upon detailed mathematical analysis of interference sources performed in accordance with the techniques contained in previous paragraphs of this Control Plan. Filter networks installed within AC input leads will be designed to withstand the transient voltage requirements specified in MIL-STD-704, Category B.

2.4.1 In no case will shielded cable be used in a primary power input circuit. All power input leads will be routed as twisted pairs, triads, or quads, depending upon the type of power. The neutral will be routed with the power high leads and grounded as previously specified in Paragraph 6.3 of this Control Plan.

2.5 GRAPHIC ANALYSIS OF PULSE TRAIN. This beacon transmitter requires an input keying signal which consists of a 5 volt (max.) pulse with a rise and fall time of 5 microseconds. This pulse is applied at a repetition rate of 20K bits/second. A spectral presentation of this pulse showing radiated emission amplitude vs frequency appears in Figure B-1. This graphic data will be used to determine the containment requirements for input pulse cable and transmitter enclosure.

2.6 OUTPUT SIGNAL CHARACTERISTICS. The transmitter spurious output will be controlled within the limits of RE 03 of MIL-STDS-461/462. The possible spurious outputs will be attenuated by installation of a bandpass filter with the following stop band characteristics:

1. At frequencies ±75 MHz above and below the center channel frequency of the beacon transmitter, the filter shall attenuate all signals a minimum of 80 dB.

2.7 CONTROL SIGNAL NOISE ENVELOPE. The beacon transmitter will be controlled by remote inputs to select the desired operating channel. Maximum voltage level of these input signals is 4.5 volts. This voltage is dropped across 1000 ohms (nominal).

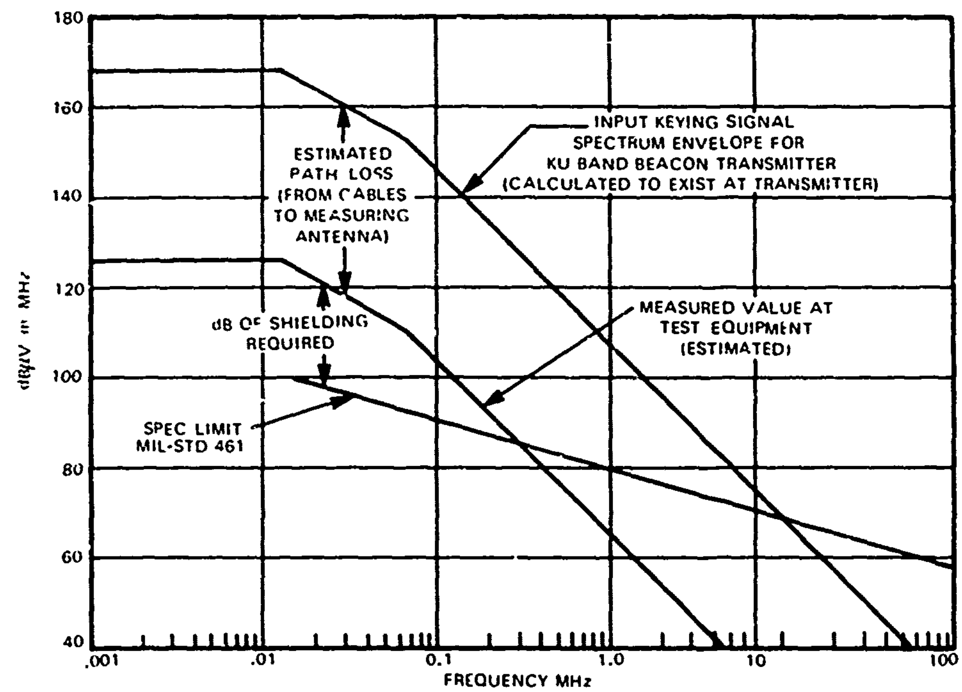


FIGURE 8-1 KU BAND BEACON TRANSMITTER CABLE SHIELDING REQUIREMENT

2.8 CHANNEL SPACING AND ENVELOPE OVERLAP. Channel overlap points and end channel frequency decay data will be included at a later date.

3.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of this Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, EMI will be monitored periodically to ensure adequacy of design in accordance with accepted and required EMI control practices. If this monitoring effort and resolution cannot be accomplished, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 13

Down Converter

1.0 GENERAL. This section contains all the interference control requirements for the down converter. This equipment is designed to receive C band RF signals from the sensor aircraft or Ku-band RF signals from the relay aircraft and process these signals into a 1370 MHz IF signal suitable for further processing. The down converter is part of the surface terminal equipment.

1.1 All requirements set forth in this section are designed to yield compliance with MIL-STDS-461/462 as required by Southwic Specification 5-42001.

2.0 ELECTRICAL DESIGN REQUIREMENTS. The following electrical design requirements will be included as a normal function of circuit development. These requirements are the means by which compliance with the radiated and susceptibility limits of MIL-STDS-461/462 is assured.

2.1 ELECTRICAL CONNECTORS. Separate electrical connectors will, if possible, be provided for power input test and control signals. The wiring configuration and pin designations for these connectors will be specified in the connector/wiring matrix. All electrical connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan.

2.2 RF CONNECTORS. Panel-mounted RF connectors will be provided for RF signal inputs and IF signal output. These connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan.

2.3 BUILT-IN TEST EQUIPMENT (BITE). The BITE circuitry incorporated into the down converter will be designed to meet the requirements of MIL-STDS-461/462. This circuitry is used during the operational mode to monitor the operation of the down converter under tactical conditions. In the test mode, a locally generated signal is used to test the down converter. Every precaution will be taken to reduce undesirable interference generation and minimize or eliminate any possible susceptibility to extraneous fields during operation and in the test mode.

2.3.1 BITE GO/NO-GO Indication. BITE outputs that visually indicate circuit GO/NO-GO status will be shielded assemblies suitable for containment of internally generated RF and the step function amplitude/frequency spectrum.

2.4 INPUT POWER. Input power filter requirements will be determined in accordance with the techniques previously specified. Since this is a primary interface, the possible requirement for decoupling networks will be evaluated. Specific details and performance calculations describing this interface will be made available to the responsible equipment design engineer.

2.4.1 In any event, primary input power will not be routed in shielded cables. Twisting of power cables, including the neutral, will be required, however, and grounding will be accomplished as specified previously in Paragraph 6.3 of this Contol Plan.

2.5 CONTROL SIGNALS. All parameters of the control signal groups will be calculated as previously specified. These data and analyses will be used by the equipment design engineer to determine the requirements for shielding and for filtering.

3.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of this Control Plan sets forth basic ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control will be monitored to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring effort and cannot be resolved, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 14

Receiver Demodulator

1.0 GENERAL. This section contains EMI control design requirements for the receiver demodulator. The receiver demodulator will be installed in the surface recording terminals. The receiver demodulator shall be capable of receiving a modulated IF signal from the down converter and shall furnish a demodulated signal to the PSK demodulator, the AN/APQ-102B signal adapter or the universal processor viewer (UPRV).

1.1 The requirements in this section provide for compliance with MIL-STDS-461/462 as specified in Southwic Specification 5-51001.

2.0 ELECTRICAL REQUIREMENTS FOR EMI CONTROL. The following requirements will be incorporated into the basic equipment design as mandatory minimums for controlling interference within the limits of MIL-STDS-461/462.

2.1 BUILT-IN TEST EQUIPMENT (BITE). The BITE circuitry incorporated into the receiver demodulator will be designed to meet the requirements of MIL-STDS-461/462. This circuitry is used during the operational mode to monitor various functions in the receiver demodulator under tactical conditions. In the test mode, locally generated signals are used in the receiver demodulator to simulate signals fed to the receiver demodulator so that this unit can be tested. Every precaution will be taken to reduce undesirable interference generation and minimize or eliminate any possible susceptibility to extraneous fields during normal operation and in the test mode.

2.2 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the equipment enclosure as shown in Figure 7 of the Control Plan. Electrical connectors incorporating filter pins will not be used as they offer very little attenuation in relatively low impedance circuits.

2.2.1 Input power and signal leads will not be mixed by routing through a common electrical connector. Signal and power leads will be separated in accordance with data provided in the cable matrix shown in Figure 6 of the Control Plan.

2.3 RF CONNECTORS. Panel type RF connectors will be bonded to the equipment enclosure as specified in Figure 7 of the Control Plan. Other types of RF connectors will be bonded to the airframe or equipment chassis at every point where they interrupt the overall coaxial system.

2.4 INPUT POWER. Input power is considered a primary interface. Interference decoupling networks as required will be located adjacent to the input power connector. The performance requirements for these networks will be based upon detailed mathematical analyses of interference sources performed in accordance with the techniques contained in previous paragraphs of this Control Plan. Filter networks installed within AC input leads will be designed to withstand the transient voltage requirements specified in MIL-STD-704, Category B.

2.4.1 In no case will shielded cable be used in a primary power input circuit. All power input leads will be routed as twisted pairs, triads, or quads, depending upon the type of power. The neutral will be routed with the power high leads and grounded as previously specified in Paragraph 613 of the Control Plan.

2.5 IF AMPLIFIER AND LEVEL STABILIZER - OUTPUT DRIVERS.

2.5.1 Signal Input Characteristics. The IF amplifier and level stabilizer will receive an IF frequency signal of the DSBSC format, either analog amplitude modulated or digitally modulated quadriphase keyed. The input frequency is 1370 MHz, bandwidth is 110 MHz. The maximum signal level is 0 dBm. The IF signal input will be transmitted through coaxial cable (up to 500 feet long). Shielding requirements for the coaxial cable will be provided to the equipment designer based upon previously specified techniques.

2.5.2 Output Signal Characteristics.

2.5.2.1 Digital PSK Output. This is an IF interface signal of DSBSC format, digitally modulated, quadriphase keyed. The signal frequency is 1370 MHz, 110 MHz bandwidth. The signal output level is 0 dBm ±1 dB. The data rate is variable from 54 to 9 megabits per second. The shielding requirements for the digital PSK output cable will be determined on the same basis as described for the IF amplifier and level stabilizer input.

NOTE: The digital PSK output cable is connected to the advanced sensor detector input. These two units make up the receiver demodulator.

2.5.2.2 Drive Output to Wideband Sensor Section. This is a double sideband suppressed carrier analog signal. The signal frequency is 1370 MHz, 110 MHz bandwidth. The signal output interference level will be calculated and these data will be made available to the equipment design engineer.

2.6 ADVANCED SENSOR DETECTOR SECTION (WIDEBAND SENSOR).

2.6.1 Signal Input Characteristics. The wideband sensor input is an interface from the IF amplifier and level stabilizer digital PSK output. The signal characteristics were previously described in Paragraph 2.5.2.1 above.

2.6.2 Output Signal Characteristics. The output signal characteristics are classified as specified in Southwic Specification 5-51001 and as such a description of these signals will not be discussed as a general part of this Control Plan. The necessary analysis will be included in a separate classified report.

3.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. Paragraph 4.0 of the Control Plan sets forth ground rules for mechanical design requirements. These ground rules include considerations for containment as well as exclusion of undesirable EMI. During actual design of the enclosure, periodic EMI control will be monitored to ensure adequacy of design in accordance with accepted and required EMI control practices. If questionable aspects become evident as a result of this monitoring effort and cannot be resolved, investigative tests will be performed upon breadboard models or actual prototype hardware. This method of continuous monitoring, analysis, and testing is in strict consonance with the requirements of this Control Plan.

Section 15

C Band Omni Antenna

1. GENERAL. This section contains EMI control design requirements for the C band omni antenna assembly, Southwic Specification 5-16901. This antenna will be installed in the relay aircraft and will transmit an omnidirectional Ku-band RF signal to the surface terminal.

1.1 Due to the passive nature of the antenna assembly, this section contains no requirements for EMI control except for electrical bonding and grounding.

2.0 MECHANICAL REQUIREMENTS FOR EMI CONTROL. See Paragraph 4.0 of the Control Plan, which details all basic mechanical construction requirements.

Section 16

Tracking Link Modulator

1.0 GENERAL. This section contains the EMI control requirements for the tracking link modulator.

1.1 The control requirements set forth in this section are consistent with the performance limits as contained in MIL-STDS-461/462 and Southwic Specification No. 5-39001.

2.0 ELECTRICAL REQUIREMENTS. The following interference control techniques and methods will be implemented during the modulator design phases as the minimum requirements that will provide for compliance with the limits of MIL-STDS-461/462.

2.1 BUILT-IN TEST EQUIPMENT (BITE). The BITE circuits incorporated into the modulator will be designed to comply with the limits of MIL-STDS-461/462. Accordingly, the methods and techniques applicable to normal operating circuits will be implemented during BITE circuit design.

2.2 ELECTRICAL CONNECTORS. Electrical connectors will be bonded to the modulator front panel as shown in Figure 7 of this Control Plan. "Filter pin" type electrical connectors will not be used at any external electrical interface since these connectors do not reduce interference by any significant degree at lower frequencies.

2.2.1 Power and signal leads will not be mixed by routing these noncompatible types in and out of the modulator on a common electrical connector. Signals such as BITE reset may, however, be routed with the power input leads since the BITE reset is a step function, and as such, is a source of RF interference that is above the limits specified in MIL-STDS-461/462. Since input power and BITE reset must be filtered to meet specification limits, these signals may be routed through a common electrical connector and filtered immediately adjacent to the input interface in a way similar to that shown in Figures 8 and 9 of this Control Plan.

2.3 RF CONNECTORS. Input and output RF signals will be routed through the equipment front panel on TNC type RF connectors. These connectors will be bonded to the front panel as shown in Figure 7 of this Control Plan. These are RF signals that must be routed on coaxial cable.

2.4 FILTER REQUIREMENTS. The DC input power leads will be filtered at the point of entry into the modulator or routed via twisted pair(s) shielded, external to the modulator. The technique to be used is subject to approval by Southwic. The preferred and most reliable technique for interference control on these leads is external shielding between the modulator and power source.

2.5 REMOTE CONTROL SWITCH PANEL. The remote control switch panel includes provisions for 37 switched functions. The function levels are 0-5 volt steps which will result in generation of interference levels above the limits established in MIL-STD-461.

Accordingly, these levels must be suppressed or contained by installation of filters or application of an overall cable shield. Filters, if used, will each occupy a volume of approximately one-half inch diameter and 2 inches in length. In addition to the size and weight of these filters, the requirements of an EMI-tight bulkhead must also be considered. In this instance, an overall cable shield is much preferred between the modulator and remote control switch panel as the means of interference control.

2.6 RUNNING TIME METER. A DC-driven elapsed time meter will be installed within the modulator. This unit must be procured as a qualified MIL-STD-461/462 component or provisions must be incorporated to suppress the operating transients within the limits of MIL-Standards. If noise filters are used at the DC power input interface, the elapsed time meter may be connected to the load side of these filters, thus eliminating the necessity of additional filtering.

2.7 INTERFACE SIGNALS. Interface signals will be controlled within the requirements of MIL-STDS-461/462 by the methods stated for each type of signal as follows:

2.7.1 Data Rate and Clock Rate. These signals are applied at a rate of 2.4K bits/second with a voltage range of 0-5 VDC. The rise time is approximately 50 microseconds. It is impractical to filter these leads to meet the radiated requirements of MIL-STDS-461/462. The best method of interference control is to route these signals on shielded twisted pair cable.

2.7.2 DC Status Signals. There are several "status signals" that are DC change of state levels. These signals change state only occasionally and may be considered transient. Consideration will be given to the possibility of filtering these leads in preference to shielding since lengthening rise time is of no consequence.

3.0 MECHANICAL ENCLOSURE. The modulator enclosure is the same envelope, featuring interference containment techniques used on other units. The band sealing, RF containment methods to be used are adequate to meet MIL-STDS-461/462 requirements.

3.1 POWER INPUT FILTER MOUNTING. If it becomes necessary to filter input DC power, an RF-tight mounting bulkhead must be incorporated next to the power input connector. Alternatively, instead of the bulkhead, the necessary filters may be incorporated into an integrated filter package that includes the input electrical connector. Estimated space requirements are:

1. Bulkhead mounted separate filters:

   A. 15 VDC Size: 5/8 inch dia. X 2 inches (each)
   B. 5 VDC Size: 1 1/4 inches dia. X 2 inches (each)
   C. 28 VDC Size: 1/2 inch dia. X 1 1/2 inches (each)

2. Integrated filter package:

   A. Size: 2 1/2 inches square X 2 inches long

Section 17

Tracking Link Demodulator

1.0 GENERAL. This section includes the interference control design requirements for the tracking link demodulator. The contents of this section supplement the overall interference control criteria set forth in previous sections of this Control Plan.

1.1 The control requirements in this section are the means by which compliance with MIL-STDS-461/462 and Southwic Specification 5-28001 will be achieved.

2.0 ELECTRICAL DESIGN. The control and containment methods discussed in the following paragraphs will be incorporated into the basic design of the demodulator to minimize or eliminate any possible future requirement for laboratory "test and fix" effort necessitated by the need for compliance with MIL-STDS-461/462.

2.1 BUILT-IN TEST EQUIPMENT (BITE). All BITE circuitry contained within the demodulator will be designed for compliance with the requirements of MIL-STDS-461/462. This requires that BITE function circuits be subjected to the same constraints that govern operational circuitry.

2.2 ELECTRICAL CONNECTORS. "Filter pin" type electrical connectors will not be used as front panel hardware since they do not attenuate acceptably at the lower frequencies as required by MIL-STD-461. These connectors may be used internally if required for inter-circuit decoupling. Power and signal wires will not be mixed or routed through a common electrical connector. Since these types of "signals" are fundamentally incompatible for several reasons, they cannot be successfully mixed under most normal circumstances.

2.2.1 Power leads that include ±15 VDC, ±5 VDC and + 28 VDC will be routed through a separate front panel connector. The BITE reset (28 VDC) step function signal may be routed with the input power leads. The input power leads must be filtered immediately adjacent to the interior side of the power connector, or they may be controlled within the requirements of MIL-STDS-461/462 by means of applying an overall braided shield external to the demodulator. If filter networks are used, the installation should be made as shown in Figures 8 and 9 of this Control Plan.

2.3 RF INPUT/OUTPUT CONNECTORS. Input and output RF signals will be routed on coaxial cable and fed through the equipment front panel on TNC type RF connectors. These TNC connectors will be bonded to the front panel as shown in Figure 7 of this Plan.

2.4 INTERFERENCE FILTERS. Input DC power must be filtered inside the equipment adjacent to the power connector. As an alternate to the use of a filter on each power lead, the various required voltages may be carried on twisted pairs with an overall shield. From the standpoint of reliability and preservation of power, the use of an overall shield is the preferred way to obtain specification compliance.

In any event, the method chosen for specification compliance is subject to Southwic approval before implementation.

2.5 REMOTE CONTROL SWITCHING. The demodulator will be provided with a remote control panel capable of switching 37 functions. Each function is activated by a 0 to 5 volt DC switched voltage step. Operation of each function switch will result in interference in excess of limits allowed by MIL-STD-461. This requires that filter networks be installed in each of the 37 leads or that the cable that interconnects the demodulator and remote control panel be jacketed with an overall braided shield. If filters are used for interference suppression, the space allotment will be approximately 1/2 inch diameter X 2 inches in length for each of the 37 circuits. Although the preferred method of specification compliance is the use of the overall shield, the method to be used is subject to Southwic approval.

2.6 ELAPSED TIME METER. The demodulator will be provided with a DC-operated elapsed time meter. This meter should be procured as a MIL-STDS-461/462 qualified unit to avoid the necessity of suppressing meter transients. If interference filters are used at the DC power input, the elapsed time meter may be connected to the noise source side of the appropriate filter, thus eliminating the need for a meter suppression network.

2.7 INPUT/OUTPUT SIGNALS. Each type of input or output signal will be controlled within the emission or susceptibility requirements of MIL-STD-461 in accordance with the following control methods:

2.7.1 AGC Signal. This is a DC analog signal that is susceptible to the levels and fields applied under the requirements of MIL-STD-461.

To eliminate susceptibility, this type of signal should be routed on a shielded, twisted pair cable.

2.7.2 Antenna Track Signal. This is a 500 pps signal, which, without filtering or containment, will produce a field above the limits allowed by MIL-STD-461. The preferred method of control consists of interference containment by means of routing on a twisted shielded pair.

2.7.3 Data Rate Signals. These signals are transmitted by interconnecting cables at a rate of 2.4K bits/second. Rise time is on the order of 50 microseconds and the peak voltage level is 5 volts. Since these characteristics produce levels in excess of those allowed by MIL-STD-461, the use of twisted pair shielded cable is the preferred technique of control. The use of decoupling filter networks may be considered if extended rise time is of no concern.

2.7.4 Tracking Initiate and Data Initiate. These are 0 to 5 volt DC signals that may either be filtered or contained through the use of shielded cable pairs. An investigation of the exact requirements will be made and the choice of control technique will be based upon the technique that is lowest in weight and affords the greatest degree of circuit reliability.

3.0 MECHANICAL DESIGN REQUIREMENTS. The demodulator mechanical envelope is the same as that used for other units. The band sealing technique used for cover closures is adequate for containment of internally generated fields. The enclosure will be bonded as previously described for the other units.

3.1 ENVELOPE REQUIREMENTS FOR FILTERS. If DC input power must be decoupled at the electrical interface, either of two methods must be used. In the first, an RF bulkhead must be installed next to the input connector and necessary filters must be mounted upon (through) this bulkhead. In the alternate method, the necessary filter networks may be incorporated into a common package that also includes the input power connector. Space requirements for either alternative are approximately as follows:

1. Bulkhead and Separate Filters:

±15 VDC	Each 5/8 inch dia. X 2 inches long
± 5 VDC	Each 1 1/4 inches dia. X 2 inches long
±28 VDC	Each 1/2 inch dia. X 1 1/2 inches long

2. Combined Network and Electrical Connector:

   A. 2 1/2 inches square X 2 inches long

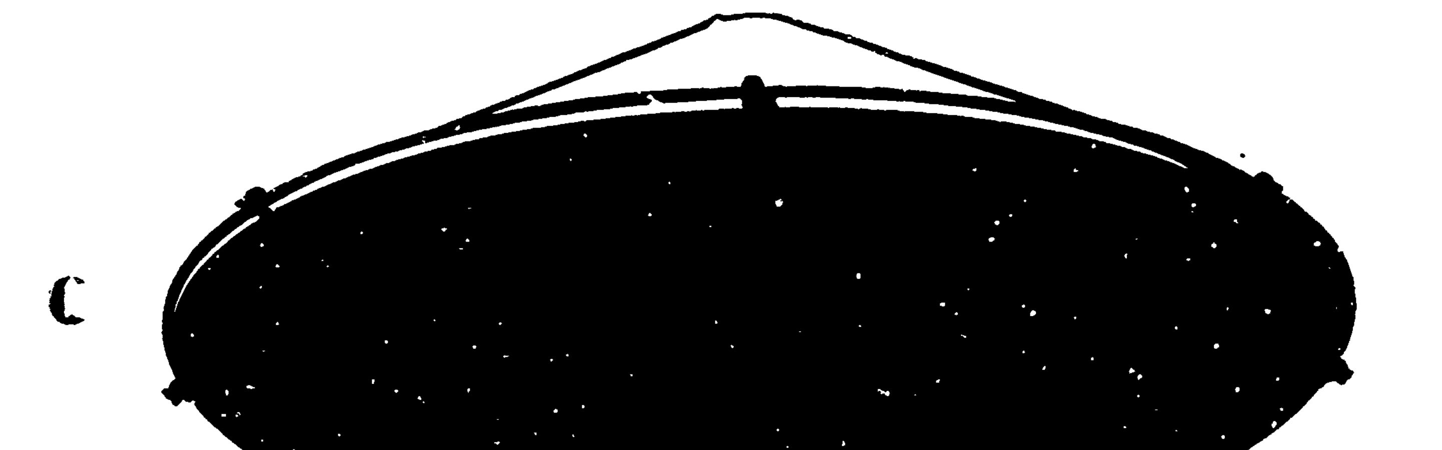
NAVAIR 5335

NAVAL AIR SYSTEMS COMMAND

ELECTROMAGNETIC COMPATIBILITY MANUAL

APPENDIX C

SAMPLE EMC TEST PLAN FOR A WEAPON SYSTEM



PUBLISHED BY DIRECTION OF COMMANDER, NAVAL AIR SYSTEMS COMMAND

APPENDIX C

SAMPLE EMC TEST PLAN FOR A WEAPON SYSTEM

PREFACE

This EMC test plan is a typical example of a system type test plan which has been prepared to meet the requirements of MIL-E-6051D. It has been included as an appendix to the NAVAIR Educational Manual as a model test plan for any weapon system. Whenever a procurement contract calls for electromagnetic compatibility in compliance with MIL-E-6051D, the contractor must prepare a test plan of this type. Section 4.2 of MIL-E-6051D, entitled "Electromagnetic Compatibility Test Program (EMCTP)," states that the EMCTP shall be developed and prepared by the contractor and documented in a test plan submitted to the procuring activity for approval. The test plan must provide for a system EMC test and an EMC general acceptance test. It includes a detailed list of information which must be included in the test plan. The test plan shall be approved before the start of formal testing.

The procuring activity or the contractor may tailor the requirements of MIL-E-6051D by modification of requirements for subsystem compatibility, degradation criteria, safety margins, or other factors as required for the specific procurement. Tailoring may also involve waivers as well as the addition of specific requirements not included in MIL-E-6051D.

The test plan, when approved by the procuring activity, constitutes a contractual agreement with the contractor showing that the test procedures of the test plan comply with all the EMC provisions of the contract and that when these tests have been passed successfully, the system has met all EMC requirements of the contract.

To avoid the necessity of putting a security clearance on this document, performance information regarding frequencies, power, sensitivity, and other characteristics given in the sample test plan are fictitious and do not apply to particular equipments.

The call-out of various makes and models of measurement equipment does not imply any preference. Equivalent measurement equipment which meets the requirements for frequency range, sensitivity, readout, accuracy, and other pertinent parameters may be used.

Seven addenda are included with this test plan. These addenda are referenced for one of two reasons: Either the material referred to in the addendum is security classified or the material could not be sufficiently defined at the time of this writing. In the case of security classified material, this is a convenient manner of handling so that only the addendum and not the complete test plan will be subject to special handling.

WANDOW AIRCRAFT ENGINEERING CORPORATION
PLYMOUTH, PENNSYLVANIA

XY-2A AIRCRAFT WEAPON SYSTEM
ELECTROMAGNETIC COMPATIBILITY TEST PLAN

ABSTRACT

This test plan defines the limits of and details the procedures for determining the degree of electromagnetic compatibility between the electrical-electronic systems comprising the XY-2A airplane.

All elements of the included systems are exercised over their operating range both actively and passively. The systems' operation is monitored to detect malfunctions during tests.

The tests are performed in an EMI-free hangar and in flight to provide comprehensive examinations to reveal possible problem areas.

CONTENTS

ADDENDA

Designation	Description
A	ECM Equipment Tests
B	Lightning Tests
C	Precipitation Static Tests
D	Discharger Tests
E	Test Frequencies for Classified Equipment
F	General Acceptance Test
G	Intersystem Compatibility Test

Note: These Addenda will become a part of this document when released.

FIGURES

TABLES

DATA SHEETS

REPORT NO. TP51-560-XY

PAGE NO. 1 OF 131

COPY NO. ____________

WANDOW AIRCRAFT ENGINEERING CORPORATION
PLYMOUTH, PENNSYLVANIA

XY-2A AIRCRAFT WEAPON SYSTEM ELECTROMAGNETIC COMPATIBILITY TEST PLAN

SUBMITTED UNDER	
REPORT NO. TP51-560-XY	DATED 14 January 197X
MODEL XY-2A	CONTRACT NO. N00018-74-C-0069
DATE ISSUED 16 January 197X	SUPERSEDING

PREPARED	REVIEWED	APPROVED
O. C. Patrick	H. L. Kenneth	L. F. Ronald
H. S. James	F. P. Henry	F. J. Josephs

REVISIONS

DATE	REV BY	PAGES AFFECTED	REMARKS

1.0 INTRODUCTION

1.1 This document contains test procedures, as required by SD-555-5, to determine the degree of compliance of the XY-2A airplane to Specification MIL-E-6051D as interpreted here.

1.2 Quantitative evaluation of electromagnetic compatibility within the electrical-avionic system, the first phase of testing, is conducted in an EMI-free, screened hangar. The second and final phase is a qualitative in-flight test, affirms the "Operationally-Acceptable" interference criteria of the hangar test, and rechecks any unacceptable interference experienced in the hangar test.

1.3 Suitable suppression techniques shall be used to reduce any interference which produces an "Operationally-Unacceptable" level.

1.4 All electrical subsystems are worked over their entire frequency range, and all sensitive equipments are monitored to insure a comprehensive test of compatibility.

1.5 Communications equipment, both transmitters and receivers, are examined for cases of interaction over and beyond their entire frequency range if prediction techniques indicate that problem areas may exist.

2.0 APPLICABLE DOCUMENTS

a. Detailed Specification SD-555-5, for model XY-2A 5-place attack airplane; Contract N00018-74-C-0069, rev. R-1, 23 December 197X.

b. MIL-E-6051D, Electromagnetic Compatibility Requirements for Systems, 7 September 1967.

c. MIL-B-5087B (ASG), Bonding, Electrical, and Lightning Protection for Aerospace Systems, 31 August 1970.

d. MIL-W-5088C, Wiring Aircraft, Installation of, 3 Sept. 1965.

e. MIL-STD-704A, Electric Power, Aircraft, Characteristics and Utilization of, 9 Aug. 1966.

f. MIL-STD-461A, Electromagnetic Interference Characteristics Requirements for Equipment, 7 Feb. 1969.

g. Wandow Report No. 71-XY-2-705, XY-2 Aircraft Weapon System Electromagnetic Compatibility Control Plan, 15 July 197X.

3.0 TEST REQUIREMENTS

3.1 TEST LOCATION

The Electromagnetic Compatibility Test of the XY-2A Aircraft Weapon System will be conducted at the Wandow Test Facility, Waterton, Pennsylvania.

3.2 ELECTRICAL BONDING MEASUREMENTS

A Shallcross Model 670A bonding meter will be used to determine whether the airplane under test meets the requirements set forth in MIL-B-5087A and in Wandow Detailed Specification SD-555-5, Rev. R-1 dated 23 December 197X. The following bonding measurements will be made:

a. Avionics bay shelves to airframe
b. Avionics equipment to airframe
c. Consoles to airframe
d. Avionics controls to airframe
e. Instrument panel to airframe
f. Instrument panel equipment to airframe

The bonding measurements will be recorded on a data sheet as indicated in data sheets 1 through 4. This data will be made part of the MIL-E-6051D Test Report.

3.3 ELECTRICAL BUS MEASUREMENT

Aircraft electrical buses will be monitored for transients incurred by the operation of the interference equipment. A micro instrument memory voltmeter Model 5201B will be connected between each of the following buses and aircraft ground:

a. ϕA primary
b. ϕB primary
c. ϕC primary
d. 28 VDC primary
e. 26 VAC reference

These measurements will be taken at the left- and right-hand circuit breaker boxes with ground power applied to the airplane. Data will be recorded on data sheet No. 5 and will meet the requirements of MIL-STD-704.

3.3.1 ELECTRICAL SUPPLY AND DISTRIBUTION

The source of electrical power on the airplane is an AC generator driven by a hydromechanical constant-speed drive. DC power is supplied by a transformer-rectifier unit. Figures 1 through 6 show the power distribution system.

3.4 ELECTRICAL AND ELECTRONIC EQUIPMENT

Electrical and electronic equipment on the airplane is divided into five categories:

a. Communications, navigation, interrogation (CNI)
b. Weapons delivery
c. Electronic countermeasures
d. Flight controls
e. Electrical equipments

Equipments to be tested will be grouped in these categories for an orderly test program.

3.4.1 ABBREVIATIONS

The following abbreviations and acronyms will be used in this test plan:

NWDC AN/ASN-91(V) Navigation/Weapon Delivery Computer
IMS AN/ASN-90(V) Inertial Measurement Set

DATA SHEET 1
BONDING DATA
LH AVIONICS BAY

SHELF	RESISTANCE – OHM
1. T-904 A/ARW-77(V)5 Bullpup Transmitter	________
2. Armament Station Control Unit 218-37628-3	________
3. AN/AVQ-7(V) HUD	________
4. AN/APR-25(V) Pulse Analyzer	________
5. AN/APR-25/27 Interface Unit	________
6. AN/ASW-25 Digital Data Communications Set	________
7. Shelf	________
8. Blanker	________

FLOOR	RESISTANCE – OHM

CHEEK BAY	RESISTANCE – OHM

KEEL	RESISTANCE – OHM

DATA SHEET 2
BONDING DATA
RH AVIONICS BAY

SHELF	RESISTANCE – OHM

FLOOR	RESISTANCE – OHM

CHEEK BAY	RESISTANCE – OHM

KEEL	RESISTANCE – OHM

DATA SHEET 3 BONDING DATA LH CONSOLE AND INSTRUMENT PANEL	
LH CONSOLE	RESISTANCE – OHM
INSTRUMENT PANEL	RESISTANCE – OHM

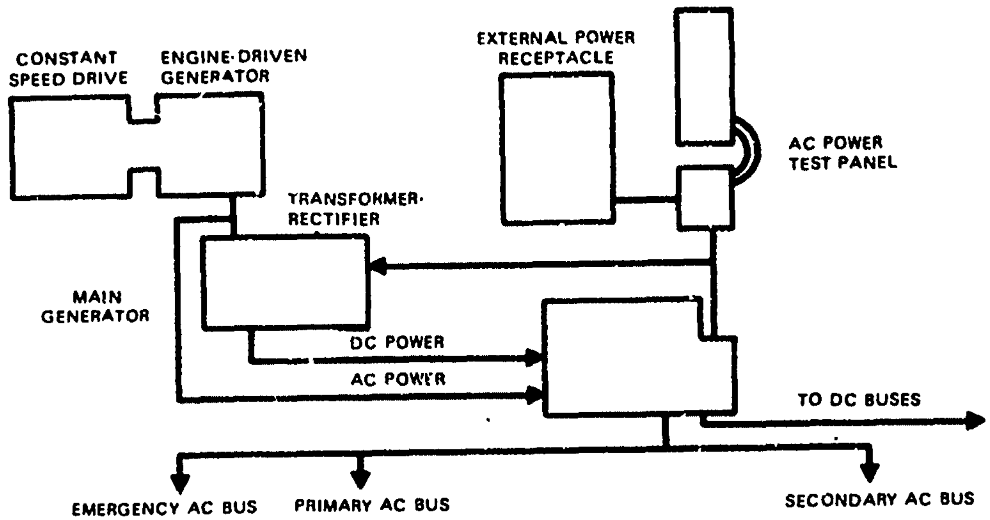
DATA SHEET 4 BONDING DATA RH CONSOLE	
RH CONSOLE.	RESISTANCE – OHM

DATA SHEET 5
BUS MEASUREMENTS DATA

LINE.	NAME:	T/S #:
MODE:	DATE:	

#	SYSTEM	REFERENCE VOLTAGE	TRANSIENT VOLTAGE	#	SYSTEM	REFERENCE VOLTAGE	TRANSIENT VOLTAGE
1 2	UHF AUX JULIET (ST)			24 25	HUD NGS (H)		
3 4	IFF AWW-2 (ST)			26 27	SIDS (ST) PMDU		
5 6	AMAC (ST) UHF			28 29	ARSTC-HK (H) DRS		
7 8	T TUNE AIC-14			30 31	ALQ-100 (ST) APR-25 (ST)		
9 10	FLAPS (H) FLR			32 33	APR-27 (ST) ECM CP (ST)		
11 12	AFCS (H) APC			34 35	ALE-29A (ST) SEAT		
13 14	GS (H) AR PROBE (H)			36 37	IND LTS NWDC		
15 16	PITOT LAUNCH (H)			38 39	INT LTS EXT LTS		
17 18	BP XTR (ST) TRIM (H)			40 41	TACAN DTA LNK		
19 20	ASCU (ST) WLYE (ST)			42 43	RDR BCN (ST) A of A		
21 22	SWD DR (ST) RDR ALT			44 45	FANS HTR BLKT		
23	HMS			46 47	KB-18 HF		
				48 49	FM LF ADF		

7



AFCS POWER
ALTIMETER, MC-3 (VIBRATOR)
ATTITUDE DIRECTOR INDICATOR, (ADI)
FLIGHT INSTRUMENT LTS
HORIZONTAL SITUATION INDICATOR (HSI)
INERTIAL MEASUREMENT SET (IMS)
PITCH & ROLL TRIM
RADIO, ARC-51B UHF
RATE GYROS (TURN RATE, YAW)
STANDBY ATTITUDE INDICATOR
WING POSITION LTS (DIM ONLY)

AIR DATA COMPUTER (ADC)
ARMAMENT STATION SELECT LIGHTS
ARMAMENT STATION POWER, STATIONS 2 AND 7
ASCU LOGIC
AUTOMATIC DIRECTION FINDER, ARA-50 (ADF) LOW FREQ. ADF ARN-59
FIRING VOLTAGE
FUEL FLOWMETER
FUEL QUANTITY
HYDRAULIC ACCUMULATOR HEATER (FLAP)
HYDRAULIC ACCUMULATOR HEATER (LG)
IFF, APX-72
LIQUID OXYGEN INDICATOR
OIL QUANTITY INDICATOR
PILOT HEAT
SEAT ADJUST
TACAN, ARN-52
TAIL POSITION LIGHT

ANTI-COLLISION LIGHTS
APPROACH POWER CONTROL (APC)
ARMAMENT STATIONS AC POWER (1 THRU 8)
BULLPUP TEST, ARW-77
CAMERA, KB18
COCKPIT WHITE FLOODLIGHTS
CONSOLE LIGHTS
ECM, ALQ-100
ECM, APR-25A
ELECTRONIC COMPARTMENT FAN
ENGINE PRESSURE RATIO INDICATOR (EPR)
FORMATION FLIGHTS
FUZING, AWW-2A
HEAD-UP DISPLAY
HYDRAULIC ACCUMULATOR HEATER (EEP)

NAV/WD COMPUTER
NON-FLIGHT INSTRUMENT LIGHTS
NOSE STEERING
PITCH & ROLL COMPUTERS
PROJECTED MAP DISPLAY
RADAR ALTIMETER
RADAR APQ-126
RADAR, DOPPLER
REFUELING, D-704 STORE
SHRIKE IMPROVED DISPLAY (SIDS)

FIGURE 1 ELECTRICAL SUPPLY AND DISTRIBUTION

DC Power from Transformer – Rectifier

EMERGENCY DC BUS	PRIMARY DC BUS
Advisory lights test	Air data computer (ADC)
AFCS power	AMAC monitor and control
Altimeter, AAU-19/A (vibrator)	Air refueling probe
AMAC	Armament station select
Antiskid caution	ASCU control
Approach lights	Automatic direction finder, ARA-50
Caution lights panel	Canopy advisory
Cockpit utility light	Chartboard light
ECM arm safe	Fuel control
Emergency flaps	Fuel dump
Engine anti-ice	Fuel transfer
Exterior lights control	Gun control and clearing, M61A1
Fire warning lights	Heading modes 1 and 2
Inertial measurement set (IMS)	IFF/APX-72
Intercommunications set, AIC-14	Interference blanking set
Jettison power and control	Landing gear handle warning light
Landing gear indication	Launch bar selector valve and warning
Leading edge flaps indication	Low fuel caution
Low hydraulic pressure caution	Oil quantity caution
Low oil pressure caution	Oxygen low caution
Manual fuel control and caution	Probe advisory
Pitch trim brake	Radio receiver, APR-69, UHF/ADF
Radio, ARC-51B UHF	Rain repel
Rain remove overheat caution	Speed brakes
Red floodlights	Standby reticle
Speech security, Juliet 28	TACAN, ARN-52
	Temperature control
	Thermal closure
	Trailing edge flaps
	Cockpit lights dimming
	Fuel filter caution
	Radio Receiver, ARN-59, LF ADF

FIGURE 2 EMERGENCY AND PRIMARY DC POWER DISTRIBUTION

DC Power from Transformer-Rectifier

SECONDARY DC BUS

Anti-skid
Approach power control (APC)
Armament station DC power
(1 through 8)
Arresting gear actuator
Auxiliary tank fueling and transfer
Bleed air
Buddy store control (D-704)
Bullpup, ARW-77
Camera, KB18
Counting accelerometer
Chaff dispensing
Data link, ASW-25A
ECM, ALQ-100
ECM receiver, APR-27
Electronic compartment fan
Emergency hydraulic pump and test
EPP actuator
Fuel transfer sequence valves
Fuzing, AWW-2A
Heading mode
Head-up display (HUD)
IFF transmitter, APX-72

Infrared cool
Intercom set, AIC-14
Land/taxi light
Light dimming control
Master armament power (1 through 8)
Tactical computer
Nose arm, LH and RH
Nose gear steering selector
Projected map display
Radar, APQ-126
Radar altimeter
Radar beacon, APN-154
Radar, Doppler
Release and fuze control
Select and firing (sta 1 through 8)
Sids display
Smoke abate
Speech security, Juliet 28
Fail arm, LH and RH
Vector warning receiver

FIGURE 3 SECONDARY D.C. POWER DISTRIBUTION

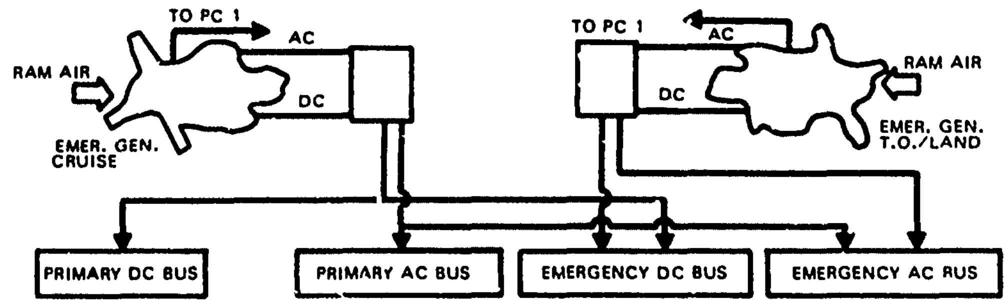


*FIGURE 4 EMERGENCY ELECTRICAL POWER DISTRIBUTION

EMERGENCY ELECTRICAL POWER DISTRIBUTION

PRIMARY DC BUS

- Air data computer (ADC)
- AMAC monitor and control
- Air refueling probe
- Armament station control
- ASCU control
- Automatic direction finder, ARA-50
- Canopy advisory
- Chartboard light
- Cockpit lights dimming
- Fuel control
- Fuel dump
- Fuel filter caution
- Fuel transfer
- Gun control and cleaning, M61A1
- Heading modes 1 and 2
- IFF/APX-72
- Interference blanking set
- Landing gear handle warning light
- Launch bar selector valve and warning
- Low fuel caution
- Oil quantity caution
- Oxygen low caution
- Probe advisory
- Radio receiver, APR-69, UHF/ADF
- Rain repel
- Speed brakes
- Standby reticle
- Tacan, ARN-52
- Temperature control
- Thermal closure
- Trailing edge flaps
- Radio receiver, ARN-59 LF ADF

PRIMARY AC BUS

- Air data computer (ADC)
- Armament station select lights
- Armament station power, stations 2 and 7
- ASCU logic
- Automatic direction finder, ARA-50 (ADF)
- Firing voltage
- Fuel flowmeter
- Fuel quantity
- Hydraulic accumulator heater (flap)
- Hydraulic accumulator heater (LG)
- IFF, APX-72
- Liquid oxygen indicator
- Oil quantity indicator
- Pitot heat
- Seat adjust
- Tacan, ARN-52
- Tail position light

EMERGENCY AC BUS

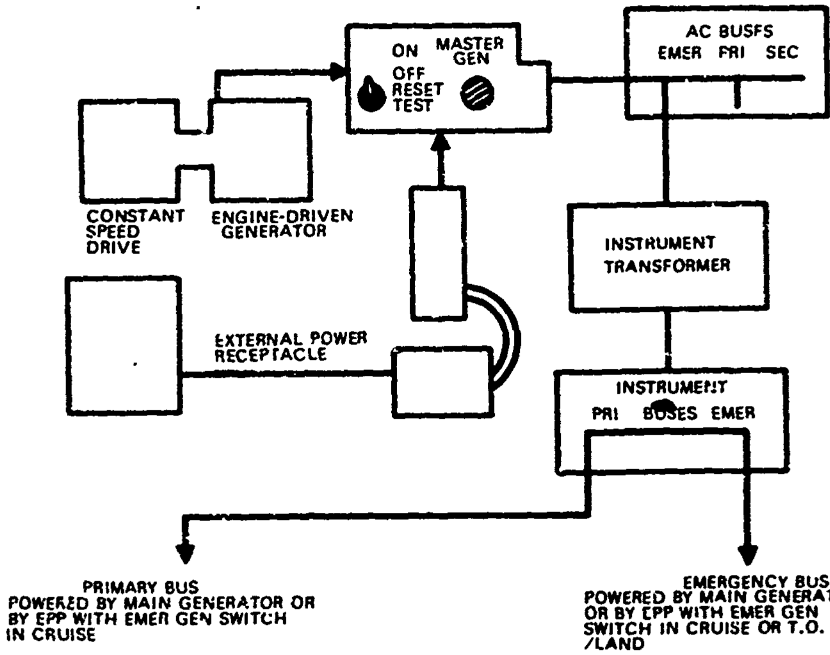
- AFCS power
- Altimeter, MC-3
- Attitude director ind.
- Flight instrument lights.
- Horizontal situation indicator
- Inertial measurement set
- Pitch and roll trim
- Radio, ARC-51B, UHF
- Rate gyros
- Standby attitude ind.
- Wing position lights

EMERGENCY DC BUS

- Advisory lights test
- AFCS
- Altimeter, AAU-19/A
- AMAC
- Antiskid caution
- Approach lights
- Caution lights panel
- Cockpit utility light
- ECM arm safe
- Emergency flaps
- Engine anti-ice
- Exterior lights control
- Fire warning lights
- Inertial measurement set (IMS)
- Intercommunications set, AIC-14
- Jettison power and control
- Landing gear indication
- Leading edge flaps
- Low hydraulic pressure caution
- Low oil pressure caution
- Manual fuel control and caution
- Pitch trim brake
- Radio, ARC-51B, UHF
- Rain remove overheat caution
- Red floodlights
- Speech security, Juliet 28
- Radio, ARC-94, HF/radio, ARC-54 VHF, FM

FIGURE 5 EMERGENCY ELECTRICAL POWER SYSTEM LOADS

INSTRUMENT BUS POWER



AUTOMATIC DIRECTION FINDER, ARA-50 (ADF)
DATA LINK, ASW-25A
NAV/WD COMPUTER
PROJECTED MAP DISPLAY SET
RATE GYRO (TURN)
SPEED BRAKE POSITION INDICATOR
TACAN, ARN-52
TRUE AIRSPEED INDICATOR

HORIZONTAL SITUATION INDICATOR
HYDRAULIC PRESSURE INDICATOR
INERTIAL MEASUREMENT SET (IMS)
OIL PRESSURE INDICATOR
PITCH AND ROLL INDICATORS
TRAILING EDGE FLAP INDICATOR

FIGURE 6 INSTRUMENT BUS POWER

FLR	AN/APQ-126 Forward Looking Radar
FM	AN/ARC-54 FM Radio Set
LFADF	AN/ARN-59 Radio Set
HF	AN/ARC-94 HF Radio Set
ASCU	218-37628-3 Armament Station Control Unit
RDR ALT	AN/APN-141(V) Radar Altimeter
BP XTR	AN/ARW-77 Radio Transmitting Set
AWW-2	AN/AWW-2A Fuse Function Control
SIDS	Shrike Improved Display System
AMAC	A/A24B-4 Armament Monitoring and Control
HUD	AN/AVQ-7(V) Head Up Display
ADC	CP-953/AJQ Air Data Computer
ADF	AN/ARA-50 Automatic Direction Finder
DTA LNK	AN/ASW-25A Data Link
DRS	AN/APN-190(V) Doppler Radar
RDR BCN	AN/APN-154(V) Radar Beacon
TACAN	AN/ARN-52 Tacan
IFF	AN/APX-72 IFF Transponder
UHF	AN/ARC-51B UHF Radio
T TUNE	Touch Tune System
A OF A	Angle of Attack
2" STBY	2" Standby Attitude Indicating System
AIC-14	AN/AIC-14 Audio System
HMS	Heading Mode System
UHF AUX	AN/ARR-69 UHF Auxiliary Receiver
PMDS	Projected Map Display System
ALQ-100	AN/ALQ-100 Countermeasures Set
APR-27	AN/APR-27 Warning Set
APR-25	AN/APR-25 Homing and Warning
CBU	MX-8253/A Interference Blanker
ALE-29A	AN/ALE-29A Dispenser Set
ECM C P	Integrated ECM Control Panel
AFCS	AN/ASW-30(V) 1 Automatic Flight Control System
APC	ASN-54(V) Approach Power Compensator
NGS	Nose Gear Steering
TRIM	Pitch and Roll Trim System
WLYE	Walleye
SDWDR	Sidewinder
SEAT	Seat Adjust
AR PROBE	Air Refueling Probe
EXT LTS	Exterior Lights
INT LTS	Interior Lights
WG FL TFR	Wing Fuel Transfer

IND LTS	Indicator Lights Switch
PITOT	Pitot Heat
FANS	Avionics Bay Fans
FLAPS	Variable Flaps System
HTR BLKT	Hydraulic Accumulator Heater Blanket
LAUNCH	Launch Bar
ARSTG HK	Arresting Hook
GUN	Gun Firing
ACC	Air Conditioning Control
TWE	Thumbwheel Encoder
GS	Gear Switching
H, HYD	Hydraulics
ST	Special Test
BNL	Background Noise Level
HYBLOW	Utility Hydraulic Blower
FIRE DT	Fire Detection Test
TQ MTR	Torque Meter System
HYD 1&2	Hydraulic Pressure, 1 and 2
EOP	Engine Oil Pressure
MCPT	Master Caution Panel Test
FBP	Fuel Boost Pump
CFFV	Cross Feed Fuel Valves
ENG COND	Engine Condition Lever
PPA	Pedal Position Actuator
FQST	Fuel Quantity System Test
WINAI	Windshield Anti-Ice
ENGAI	Engine Anti-Ice
RHAW	Radar Homing and Warning

3.4.2 EQUIPMENT LOCATION

The following figures and tables will aid in equipment and control location during bonding measurements and test procedure operation:

a. Figures 7, 8, 9 and 10.
b. Tables 1, 2, 3, 4, 5 and 6.

3.4.3 INTERFERENCE EQUIPMENT

Table 7 is a list of the offending equipments that will be used in normal operating conditions and in the most interference prone conditions to try to interfere with the susceptible equipments.

3.4.4 SUSCEPTIBLE EQUIPMENT

Table 8 is a list of the victim equipments whose outputs will be monitored for malfunction and will operate at the threshold of susceptibility, if possible.

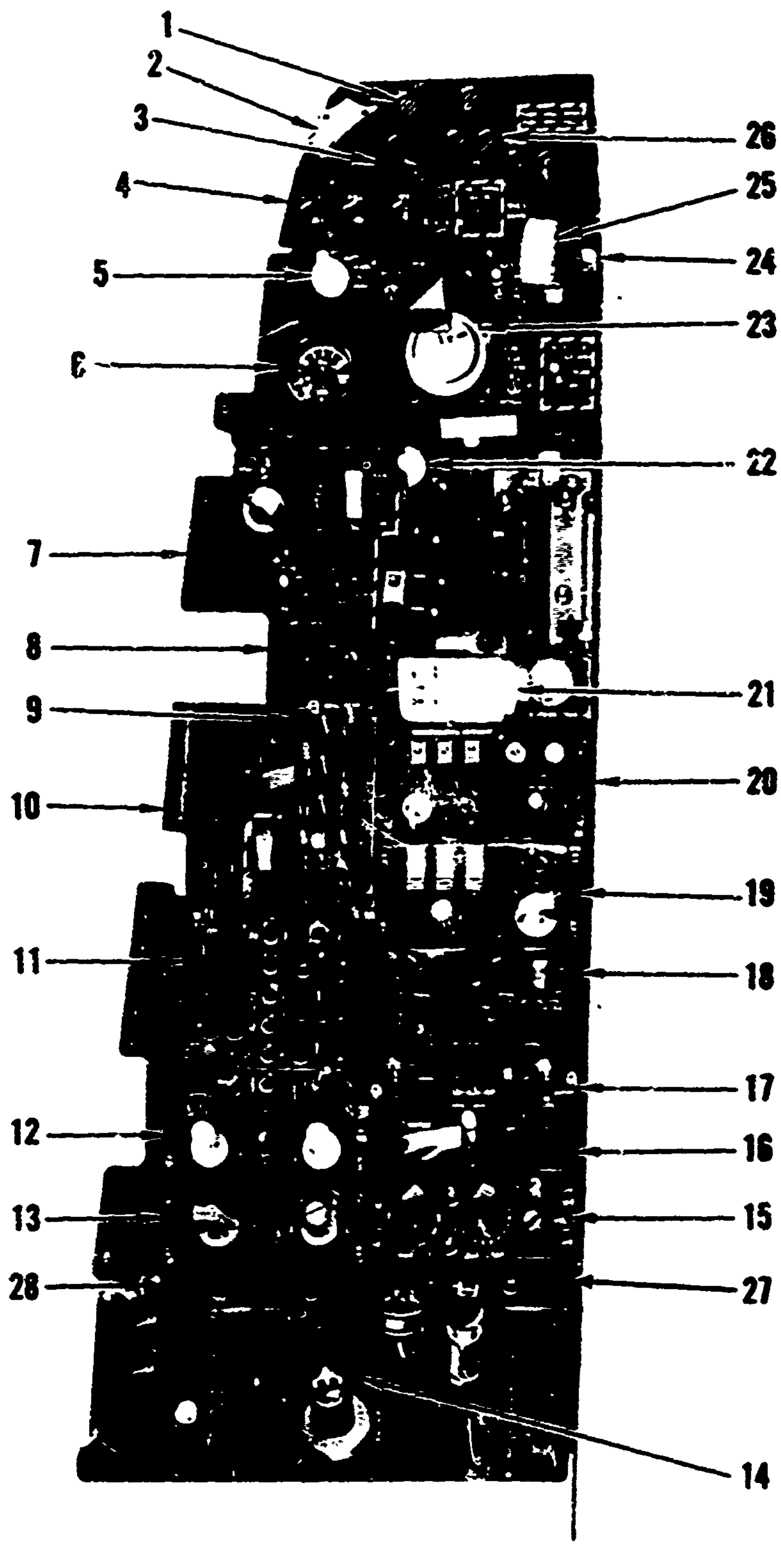
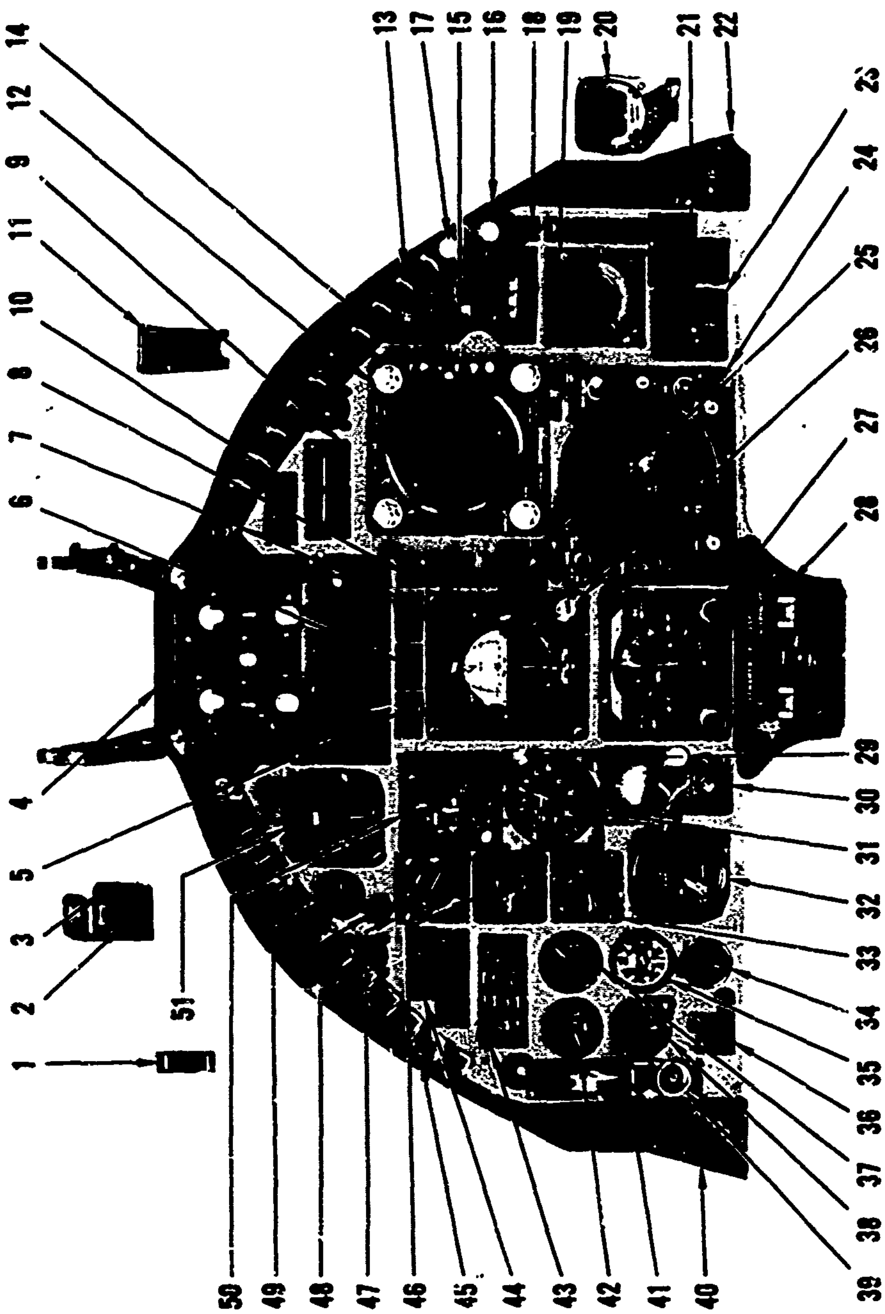


FIGURE 7 LEFT CONSOLE AREA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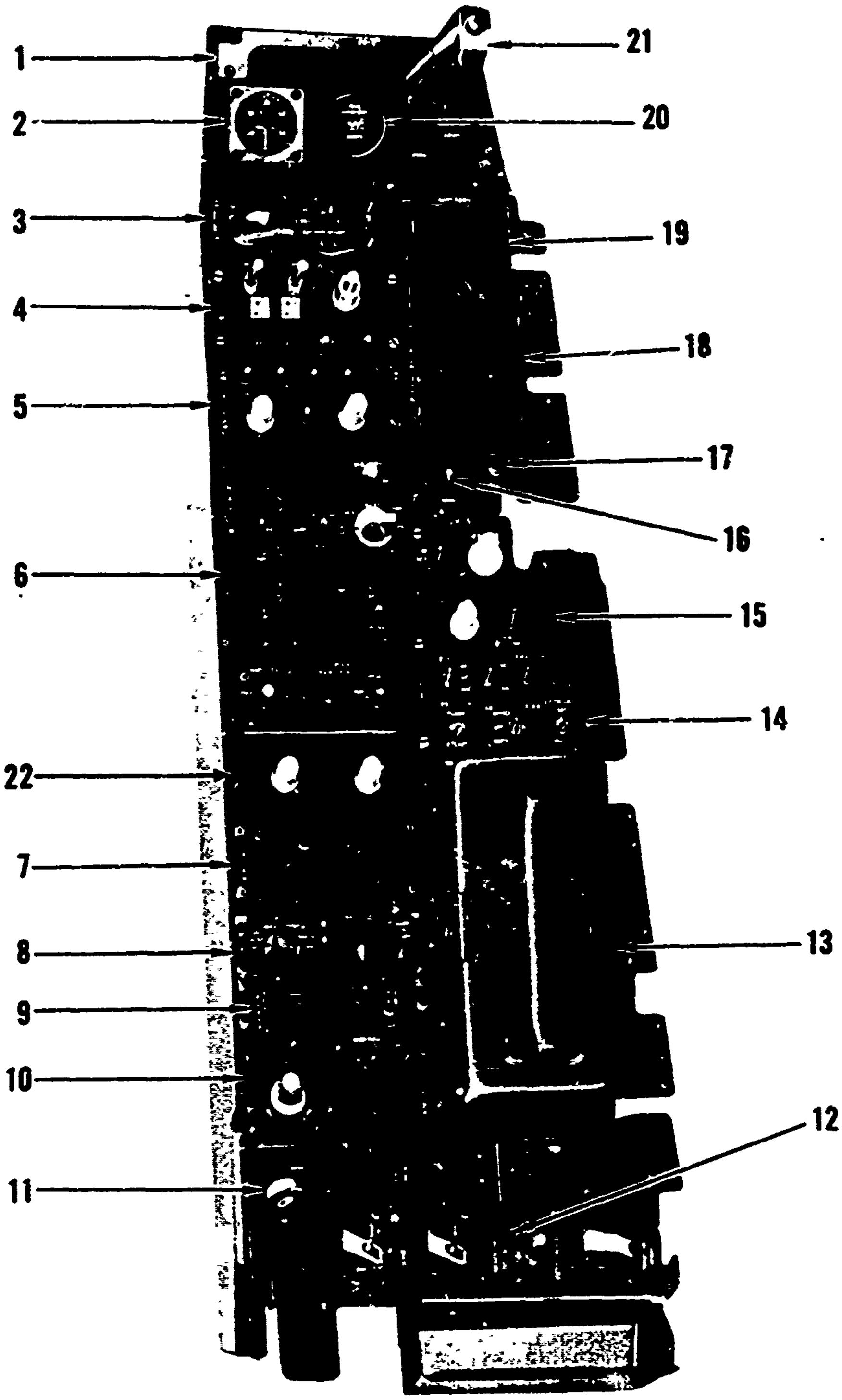
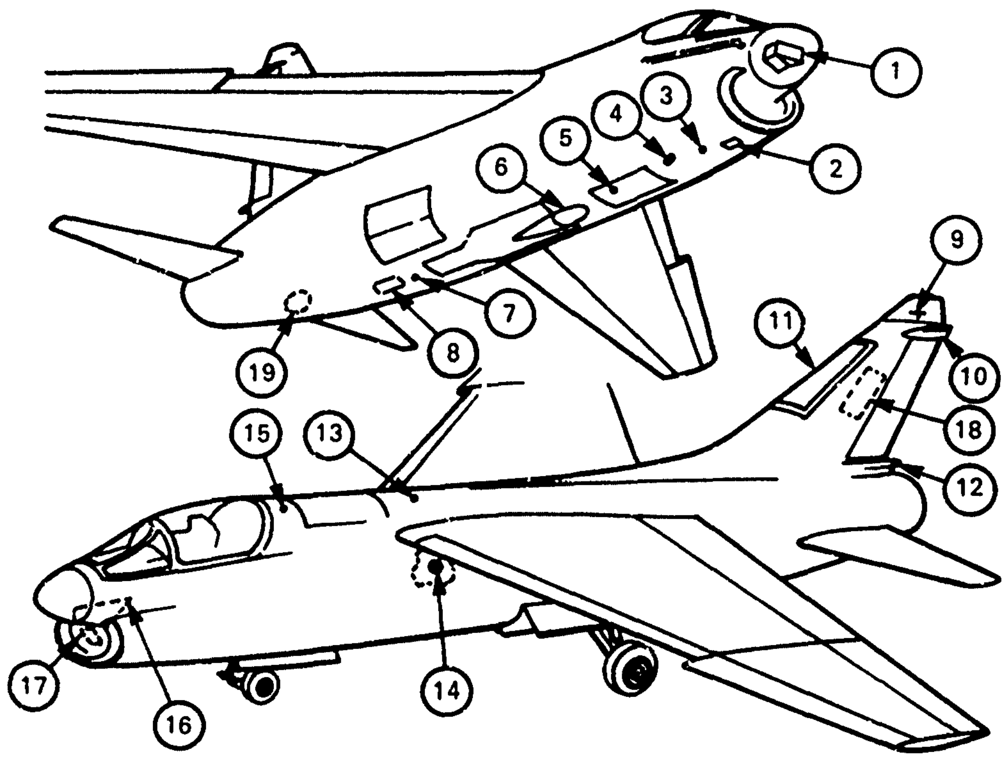


FIGURE 9 RIGHT CONSOLE AREA



1. AN/APQ 126 PRIMARY RADAR
2. AN/ARA 50 ADF
   AN/ARR 69 UHF AUX RADIO
3. AN/APN 154 RADAR BEACON
4. APR-27 ECM WARNING
5. AN/APN 141 RADAR ALTIMETER
6. AN/APN 190 DOPPLER RADAR
7. AN/ARN 52 TACAN (LOWER)
8. AN/ALQ 100 ECM TRANSMITTER
9. AN/ARC 51B UHF VOICE RADIO/ APX 72 IFF
10. AN/APR-25 AFT ECM RECEIVER
11. AN/ARC-94 HF VOICE RADIO
12. AN/ALQ 100 AFT ECM RECEIVER
13. AN/ARN 52 TACAN (UPPER)/ASW 25 DATA LINK
14. AN/ARW 77 BULLPUP TRANSMITTER
15. AN/APR-27 ECM RECEIVER (UPPER)
16. AN/APR-25 FWD RECEIVER (LH & RH)
17. AN/ALQ 100 FWD ECM RECEIVER
18. AN/ARC-54 FM VOICE RADIO
19. AN/ARN-59 LF ADF

FIGURE 10 XY-2A ANTENNA SYSTEM LOCATIONS

TABLE 1

LEFT HAND CONSOLE COMPLEMENT

1. LE Flaps Position Indicator
2. Emergency Power Handle
3. TE Flaps Position Indicator
4. AFCS Trim Indicators
5. AFCS Test Control
6. Roll Pitch Trim Indicator
7. Fuel Management Panel
8. Approach Power Control Panel
9. AFCS Control Panel
10. Flaps Control Panel
11. IFF Control Panel
12. Audio System Control Panel
13. Suit Vent Air Control Panel
14. Liquid Oxygen Quantity Indicator
15. Auxiliary UHF Control Panel
16. Juliet 28 Control Panel
17. Data Link Control Panel
18. AWW-2A Fuse Function Control Panel
19. UHF Control Panel
20. Forward Looking Radar Control Panel
21. Throttle Control
22. Emergency Brake Control Handle
23. Bullpup Control Stick
24. Generator Control Panel
25. Landing Gear Control Handle
26. Landing Gear Position Indicators
27. HF Control Panel
28. FM Control Panel

TABLE 2

INSTRUMENT PANEL COMPLEMENT

1.	Approach Indexer	27.	Horizontal Situation Indicator
2.	Wheels/Flaps Warning Light	28.	Armament Release Control
3.	APC Off Light	29.	Standby Attitude Indicator
4.	Head-Up Display	30.	Heading Mode Select Switch
5.	Master Caution Light	31.	Airspeed Indicator
6.	Fire Warning Light	32.	Fuel Quantity Indicator
7.	Launch Bar Caution Light	33.	Accelerometer
8.	Data Link Landing Lights	34.	Oil Pressure Indicator
9.	UHF Frequency/Channel Indicator	35.	Fuel Flow Indicator
10.	Armament Advisory Lights	36.	Oil Quantity Indicator
11.	Radar Warning Lights	37.	Tachometer
12.	Forward Looking Radar Indicator	38.	Engine Pressure Ratio Indicator
13.	Radar Panel Lights Switch	39.	Salvo Jettison Switch
14.	Armament Select Switches/Lights	40.	Landing Checklist
15.	Terrain Clearance Set Control	41.	Auxiliary Jettison Switch
16.	Radar Range Set Control	42.	Turbine Inlet Temperature Indicator
17.	Armament Select Lights Dimming Control	43.	Master Function Switch
18.	Radar Warning Lights	44.	Armament Advisory Lights
19.	APR-25(V) Indicator	45.	Armament Select Switches/Lights
20.	Standby Compass	46.	Vertical Velocity Indicator
21.	Data Link Lights	47.	Angle of Attack Indicator
22.	Takeoff Checklist	48.	Low Altitude Warning Light
23.	Clock	49.	Speed Brake Position Indicator
24.	Projected Map Display	50.	Barometric Altimeter
25.	Shrike Display Mode Control	51.	Radar Altimeter
26.	Attitude Director Indicator		

TABLE 3

RIGHT HAND CONSOLE COMPLEMENT

1. Hydraulic Pressure Indicators
2. Cabin Pressure Altimeter
3. Doppler Radar Control Panel
4. ECM Control Panel
5. APR-25/27 Control Panel
6. Integrated NAV/WD Computer Panel
7. TACAN Control Panel
8. IMS Control Panel
9. Radar Beacon Control Panel
10. Environmental System Control Panel
11. Wingfold Control Handle
12. Special Weapons Control Panel
13. NAV Bag
14. Exterior Lights Panel
15. Interior Lights Panel
16. Seat Adjust
17. Caution and Advisory Lights Press-To-Test
18. Caution Lights
19. Advisory Lights
20. True Airspeed Indicator
21. Arresting Hook Control Handle
22. LF ADF Control Box

TABLE 4

AVIONICS EQUIPMENT LH AVIONICS BAY

SHELF

1. T-904 A/ARW-77(V) Bullpup Transmitter
2. Armament Station Control Unit 218-37628-3
3. 216-37267 HUD
4. MX-8253/A Interference Blanker
5. Heading Mode System Relay Box
6. 215-37311 Relay Rack
7. 215-37271 Battery
8. AN/APR-25(V) Pulse Analyzer
9. AN/APR-25/27 Interface Unit
10. AN/ASW-25 Digital Data Communications Set
11. External Power Monitor
12. Buddy Refueling and Miscellaneous Relay Box
13. Smoke Abatement Altitude Switch

FLOOR

1. 215-37121 AFCS Amplifier and Computer
2. AN/ASN-91(V) Nav/WD Computer
3. ASN-90 Inertial Measuring Unit
4. LORAN (provisions only)
5. Camera Control Unit
6. ARC-51B Touch Tune Switching Unit

CHEEK BAY

1. MS17399 Rate Switching Gyroscope
2. T751/AJB-3A Rate Transmitting Gyroscope
3. ASN-54(V) Approach Power Compensator Computer
4. 215-37134 Pitch, Roll Trim Amplifier
5. Pitch, Roll Trim Test Plug
6. 215-37135 Generator Control Panel
7. AM-4364/ASN-54(V) APC Servo Amplifier
8. AS-1233/APN-141(V) Antenna
9. External Power Plug

KEEL

1. 215-37178-1 APC Accelerometer
2. 215-37129-2 Normal Attitude Rate Change Accelerometer

TABLE 5

AVIONICS EQUIPMENT, RH AVIONICS BAY

SHELF

1. AN/ARC-51B UHF Radio Set
2. JULIET 28
3. AIMS Trans-Tester
4. CP-953/AJQ Air Data Computer
5. CN-1169/A 2-Inch Standby Compass Gyroscope
6. R-1286/ARR-69 UHF/ADF Auxiliary Receiver
7. AM-3624/ARA-50 ADF Control Amplifier
8. R-1412/APR-27 Radar Receiver
9. 215-37311 Relay Rack
10. AN/ARC-94 HF Radio Set

FLOOR

1. ALQ-100 Self-Test
2. ARN-52(V) TACAN
3. RT-848/ALQ-100 Receiver-Transmitter
4. APN-190 Doppler Radar
5. PMDS Electronic Unit
6. APX-72 IFF Transponder Set
7. AN/ARC-54 FM Radio Set

CHEEK BAY

1. CVC 5861-2 DC Relays (2)
2. 215-27718-2 Relay
3. CU-1464/APN-141 Coupler Linearizer
4. SA-791 A/APN-141 RF Switching Unit
5. RT 601B/APN-141 Receiver-Transmitter
6. CV 18-207503 Mainline Power Contactor Relay
7. MS 24140D1 Relay, Land Taxi Light
8. 215-37135-2 Current Transformers (3)
9. AS-1233/APN-141(V) Antenna
10. AN/ARN-59 LF ADF Receiver

KEEL

1. 215-37151 Diplexer
2. CN-1083/ASW-26 Three-Axis Rate Gyroscope
3. MX-8278/ASQ Initiator, Destruct Igniter

TABLE 6

ANTENNA SYSTEMS

AVIONIC SYSTEM AND FUNCTION	ANTENNA PART NO. AND TYPE	FREQUENCY RANGE MHz
RADAR		
AN/APQ-126		
Primary Radar	Controlled Paraboloid	Classified
COMMUNICATIONS		
AN/ARC-51B	CVE-150191-1	
UHF Voice Radio	Fin Cap Dipole	225-399.9!
AN/ARC-54 VHF FM		
AN/ARR-69	CVE-150191-	
UHF Auxiliary Radio	Fin Cap Dipole	265.2-284.2
AN/ARC-94 HF Voice Radio	Monopole	2.0-29.999
IDENTIFICATION		
AN/APX-72	CVE-150191-1	
IFF	Fin Cap Dipole	1030 and 1090
AN/APN-154	AS-(1739A)/APN-154	
Radar Beacon	Discone	8500-9600
NAVIGATION		
AN/APN-141	AS-1233/APN-141	
Radar Altimeter	Flush Mounted	4300
AN/APN-190	AS-2262/APN-190	
Doppler Radar	Slotted Array	13,325 ±50
AN/ARA-50	AS-909/ARA-48	
UHF/ADF	Flush Mounted	225-399.95
AN/ARN-52	CV21-01001	
TACAN (lower)	Blade	962-1213
AN/ARN-52	218-77514	
TACAN (upper)	Dual Blade	962-1213
and		
AN/ASW-25		300-325
Data Link		
AN/ARN-92		
LORAN	Vertical Stab	90-110 kHz
AN/ARN-59		.190-1.750
LF ADF	Flush Mounted Loop	

TABLE 6

ANTENNA SYSTEMS (continued)

AVIONIC SYSTEM AND FUNCTION	ANTENNA PART NO. AND TYPE	FREQUENCY RANGE MHz
ECM (ACTIVE)		
AN/ALQ-100 Transmit Antennas (2 forward-looking and 2 aft-looking)	Sanders Assoc. P/N 2384603 Long Conical	Classified
AN/ALQ-100 Forward Receiver	VAD P/N 213-27510-1 Flat Spiral	Classified
AN/ALQ-100 Aft Receiver Antenna	Sanders Assoc. P/N 23473G2 Log Conical	Classified
WEAPONS RELEASE		
AN/ARW-77 Bullpup Transmitter	215-37130-1	Classified
RADAR WARNING SYSTEM		
AN/APR-25 Forward LH Antenna	ATI P/N 21-014794-01	Classified
AN/APR-25 Forward RH Antenna	ATI P/N 21-014794-01	Classified
AN/APR-27 Lower Antenna	AT 741/A	Classified
AN/APR-27 Upper Antenna	AT 741/A	Classified
AN/APR-25 Aft Antennas	ATI P/N 21-014794-01	Classified

TABLE 7

INTERFERENCE EQUIPMENT

WEAPONS DELIVERY

1. AN/ASN-91(V) Navigation/Weapon Delivery Computer
2. Heads Up Display
3. AN/APQ-126 Forward Looking Radar
4. VAD 218-37628-3 Armament Station Control Unit
5. AN/APN-141(V) Radar Altimeter
6. AN/ARW-77 Radio Transmitting Set
7. AN/AWW-2A Fuse Function Control
8. Shrike Improved Display System
9. A/A24B-4 Armament Monitoring and Control
10. Walleye
11. Sidewinder
12. Camera KB-18

ELECTRICAL

1. Seat Adjust
2. Air Refueling Probe
3. Exterior Lights
4. Wing Fuel Transfer
5. Indicator Lights Switch
6. Interior Lights
7. Pitot Heat
8. Electronic Compartment Fans
9. Variable Flaps System
10. Hydraulic Accumulator Heater Blanket
11. Launch Bar
12. Arresting Hook
13. Gear Switching
14. Utility Hydraulic Blower
15. Fire Detection Test
16. Torque Meter System
17. Hydraulic Pressure, #1 and #2
18. Engine Oil Pressure
19. Master Caution Panel Test
20. Fuel Boost Pump
21. Cross Feed Fuel Valves
22. Engine Condition Lever
23. Pedal Position Actuator

TABLE 7

INTERFERENCE EQUIPMENT (continued)

24. Fuel Quantity System Test
25. Windshield Anti-Ice
26. Engine Anti-Ice

COMMUNICATIONS, NAVIGATION, INTERROGATION

1. CP 953/AJQ Air Data Computer
2. AN/ARA-50 Automatic Direction Finder
3. AN/ASW-25A Data Link
4. AN/APN-190(V) Doppler Radar
5. AN/APN-154(V) Radar Beacon
6. AN/ARN-52 TACAN
7. AN/APX-72 IFF Transponder
8. ARR 69(V) UHF AUX
9. AN/ARC-51B UHF Radio
10. Touch Tune System
11. Angle of Attack
12. Heading Mode System
13. AN/AIC-14 Audio System
14. Projected Map Display System
15. AN/ARC-94 HF Radio Set
16. AN/ARC-54 FM Radio Set
17. AN/ARN-59 LF ADF

ELECTRONIC COUNTERMEASURES

1. AN/ALQ-100 Countermeasure Set
2. AN/APR-27 Warning Set
3. AN/APR-25 Homing and Warning
4. AN/ALE-29A Dispenser Set
5. Integrated ECM Control Panel

FLIGHT CONTROLS

1. AN/ASW-30(V) 1 Automatic Flight Control System
2. ASN-54(V) Approach Power Compensator
3. Nose Gear Steering
4. Pitch and Roll Trim System

TABLE 8

SUSCEPTIBLE EQUIPMENT

COMMUNICATIONS, NAVIGATION INTERROGATION

1. CP-953/AJQ Air Data Computer
2. Angle of Attack
3. Two-Inch Standby Attitude System
4. AN/AIC Audio System
5. AN/ARA-50 Automatic Direction Finder
6. AN/ASW-25A Data Link
7. AN/APN-190(V) Doppler Radar
8. Heading Mode System
9. AN/APN-154(V) Radar Beacon
10. AN/ARN-52 TACAN
11. AN/APX-72 IFF Transponder
12. AN/ARR-69 UHF Auxiliary
13. AN/ARC-51B UHF Radio
14. Projected Map Display System
15. AN/ARC-94 HF Radio Set
16. AN/ARC-54 FM Radio Set
17. AN/ARN-59 IF ADJ

WEAPONS DELIVERY

1. AN/ASN-91(V) Navigation Weapon Delivery Computer
2. AN/ASN-90(V) Inertial Measurement Set
3. AN/AVQ-7(V) Head Up Display
4. AN/APQ-126 Forward Looking Radar
5. VAD 218-37628-3 Armament Station Control Unit
6. AN/APN-141(V) Radar Altimeter
7. Shrike improved Display System
8. AN/ARW-77 Radio Transmitting Set
9. Walleye
10. Sidewinder
11. Armament Firing Lines

ELECTRONIC COUNTERMEASURES

1. AN/ALQ-100 Countermeasure Set
2. AN/APR-27 Warning Set
3. AN/APR-25 Homing and Warning
4. AN/ALE-29A Dispenser Set
5. Integrated ECM Control Panel

TABLE 8

SUSCEPTIBLE EQUIPMENT (continued)

FLIGHT CONTROLS

1. AN/ASW-30(V) 1 Automatic Flight Control System
2. ASN-54(V) Approach Power Compensator
3. Pitch and Roll Trim System

TABLE 9

TEST EQUIPMENT REQUIREMENTS

General Equipment

1. External hydraulic power
2. External electric power
3. Wing jacks
4. 2 access stands
5. 120 VAC, 60 Hz and three 50-ft extension cords

AFCS

1. Surface protractors

ADC

1. ADC test set (VPT-10F)

ADF

1. Signal generator (HP 308D)
2. Headset and mike (H-157)
3. Antenna (shop manufacture) (BNC male connector and a 10-ft piece of coax.)

ICS

1. Remote headset and mike with long cable
2. Hewlett-Packard 403B battery operated voltmeter
3. Hewlett-Packard 400E battery operated voltmeter

Data Link

1. AN/SM-511 test set
2. Test set antenna

TACAN

1. AN/ARM-25 or AN/URM-101 test set

FLR

1. Eccosorb

NWDC

1. CADU
2. Lattest operational flight program

AMAC

1. AMAC adapter harness 218-27721-1

Radar Beacon

1. AN/APM-230 test set

TABLE 9

TEST EQUIPMENT REQUIREMENTS (continued)

IFF Transponder

1. AN/APM-123A test set

Bonding Meter

1. Shallcross Model 670A milliohmeter

ALQ-100 Countermeasure Set

1. ATI P/N 30-16716-01 high power test set

Homing and Warning Set (AN/APR-25/27)

1. ATI P/N 30-16716-01 high power test set

Weapon Systems

1. A-7 compatibility pak 5821500-517
2. MAU 9/A/A bomb rack (Quan. 6) A/A 37B-6
3. MER (Quan. 6)
4. NF-105 field intensity meter
5. Tektronix 564 memory oscilloscope

Walleye

1. MK 1 MOD 0 (Walleye) practice, guided bomb
2. Adapter harness (same as 218-99705 harness with the wire on P908-e removed)

Sidewinder

1. LAU-7A launcher (2)
2. AN/ASM-20 guided missile launcher tester

SIDS

1. AN/ASM-149 test set
2. Adapter harness 218-977-1
3. Shrike disconnect to test set adapter harness

ARW-77

1. AN/USM-248 test set
2. Crystals (2)

Personnel Hazards Test

1. Narda 440 power meter
2. Directional coupler, Narda 3003-20
3. Coaxial cable
4. Horn antenna, waveline model 299

3.5 TEST EQUIPMENT

Table 9 lists the test equipment and equipment simulators necessary for performing test procedures. This equipment will be in proper working order and will be recently calibrated.

3.6 TEST PERSONNEL

The EMC test team will consist of an EMC engineer and an engineering technician. The EMC engineer will direct the test program for his particular shift. He will be responsible for scheduling, assuring the availability of support personnel and equipment, briefing the complete test team, and coordinating similar activities. During the test the engineer will perform the test procedures and record the data. The engineering technician will assist the engineer in test equipment readiness, aircraft equipment operation, and data taking.

3.7 TEST SUPPORT

Necessary support including aircraft equipment, test equipment, personnel, maintenance, and aircraft service will be provided to guarantee completion in the time allotted for testing.

3.7.1 CONFIGURATION OF TEST AIRPLANE

The test airplane will be a production XY-2A airplane fully equipped with all electrical and electronic equipment and systems with associated interconnecting cabling, control panels, sensors, and antennas. The test airplane will be devoid of all instrumentation equipment and instrumentation cabling except that required for performing the electromagnetic compatibility tests.

3.7.2 GROUND TEST FACILITIES

The necessary electric and hydraulic power carts, air conditioning, and ground handling equipment will be provided.

3.8 ENGINE RUN

Engine run time will be devoted primarily to investigation of discovered compatibility problems and to the measurement of power bus transients. Electrical bus measurements will investigate the higher transient values observed in paragraph 3.3. These measurements will be recorded on data sheet 5.

3.9 DEVIATIONS

Deviations to MIL-STD-461A are listed in paragraph 3.17.10 of the XY-2A Detail Specification.

3.9.1 AVIONICS

The following operations of the AN/APQ-126 forward looking radar are listed as deviations:

a. TV manual override
b. Intermode switching
c. Range scale

These operations will be performed during the normal FLR interference operation, and susceptible equipments will be monitored for undesirable response.

3.9.2 ELECTRICAL

The following electrical items are listed as deviations:

a. Pneumatic bottle heater blanket
b. Rain removal system thermostatic switch
c. Hydraulic accumulator heater blanket
d. Avionics compartment cooling pressure switch
e. Gun compartment vent solenoid valve
f. APC computer relays
g. Wing pressurization system thermostatic switch

4.0 TEST PHILOSOPHY AND PROCEDURES

4.1 AIRPLANE CONFIGURATION AND TEST PHILOSOPHY

The NAV-weapon delivery systems (FLR, ADC, IMS, HUD, NAV/WD computer and DRS) will, for the most part, be operated as subsystems. This is feasible because of the integrated nature of these equipments. This will be done by loading the latest Operational Flight Program (OFP) into the NWDC and using readout and display information on the HUD, the NAV/WD panel, advisory panel lights, etc., for determining any undesirable response or malfunction.

To use the OFP to its maximum, flight conditions must be simulated as much as possible. For this reason, test sets will be used in conjunction with some of the equipments. The airplane will be placed on wing jacks to enable the NWDC to provide destination count down and to actuate the landing gear as a potential interference source.

All susceptible equipments will be operated as victim equipments in all modes, while the offender equipments or interference sources are operated one at a time; then, as much as possible, simultaneously. Outputs and displays of victims will be monitored for possible malfunction or interference while being subjected to the offenders.

The test will be conducted using external and engine-driven power.

Data will be recorded as shown in data sheets 6 and 7 unless special data sheets are furnished.

4.1.1 SIGNAL-TO-OVERRIDE TEST

The amount of degradation will be determined by the "signal-to-override" test procedure whenever interference is encountered and where this type of test is practicable. The signal-to-override measurement measures the degradation of equipment performance produced by an interference source.

4.1.1.1 Measurement

Measurements are made by radiating a "desired signal" into the antenna of the victim equipment to obtain a reference level with the interference source off. The interference source is then energized and the desired signal output is increased until the reference conditions are again obtained. The required increase in a desired signal is a measure of the degradation produced by the interference source.

4.1.1.2 Simulated Signal Method

When the desired signal source is a signal generator (signal simulator), the required increase in signal level in dB is a measure of the degradation.

DATA SHEET 6
EMC DATA

VICTIM:	NAME:	T/S #:
MODE:	DATE:	

#	OFFENDER	EMC DETAIL DATA SHEET	#	OFFENDER	EMC DETAIL DATA SHEET
1	UHF AUX ARR 69		34	HUD	
2	ADC		35	NGS (H)	
3	IFF		36	SIDS (ST)	
4	AWW-2 (ST)		37	PMDS	
5	AMAC-A/A24B-4 (ST)		38	ARSTG-HK (H)	
6	UHF AN/ARC-51B		39	DRS-AN/APN-190	
7	T TUNE		40	ALQ-100 (ST)	
8	AIC-14		41	APR-25 (ST)	
9	FLAPS (H)		42	APR-27 (ST)	
10	FLR-AN/APQ-126		43	ECM CP (ST)	
11	AFCS AN/ASW-30 (H)		44	ALE-29A (ST)	
12	APC ASN-54 (H)		45	SEAT	
13	GS (H)		46	IND LTS	
14	AR PROBE (H)		47	NWDC. AN/ASN-91	
15	PITOT		48	INT LTS	
16	LAUNCH (H)		49	EXT LTS	
17	BP XTR. AN/ARW-77 (ST)		50	TACAN-AN/ARN-52	
18	TRIM (H)		51	DTA LNK-AN/ASW-25A	
19	ASCU (ST)		52	RDR BCN AN/APN-154 (ST)	
20	WLYE (ST)		53	A of A	
21	SDW DR (ST)		54	FANS	
22	RDR ALT-AN/APN-141		55	HTR. BLKT	
23	HMS		56	KF-18	
24	WG FLTFR		57	ARC-94 HF	
25	HYBLOW		58	ARC-54 VHF FM	
26	ADF. AN/ARA-50		59	ARN-59 LF ADF	
27	FIRE DT		60	CSFV	
28	TQ MTR		61	ENG COND	
29	HYD 1 and 2		62	ENGAI	
30	EOP		63	FQST	
31	MCPT		64	WINAI	
32	FBP				
33	PPA				

DATA SHEET 7
EMC DETAIL DATA

Reference No. ________

Susceptible
Equipment Affected: ____________________ Serial No. ____________

Condition of Operation and Description of Interference Source	Channel or Frequency	Background Level (Volt)		Noise Values Measured	
		Phan. Ant.	Reg. Ant.	Volts	dB above BNL

CORRECTIVE MEASURES INCORPORATED	PURPOSE OF TEST	POWER SOURCE
	Initial Correction Final Ground Flight	Ship's Battery Ship's Generator External Battery External DC Gen. External AC Gen.

ENGINE

- Running
- Stopped

OUTPUT METER

Model
Serial No. ________

TYPE OF TEST

- Compliance
- General Accept.

Airplane Model ________
Svc. No. ________
Shop No. ________

TEST CONDUCTED BY: **DATE:**

4.1.1.3 Actual Signal Method

When the desired signal is obtained by flying a radial course from a desired signal transmitter, the ratio of the operating ranges is a measure of the degradation.

$$\frac{\text{Range (Interference ON)}}{\text{Range (Interference OFF)}}$$

This can be converted to dB by:

$$\text{dB} = 20 \log \frac{\text{Range (Interference ON)}}{\text{Range (Interference OFF)}}$$

4.1.1.4 Example of Signal-to-Override Test

To demonstrate the application of the signal-to-override test, an example is given for the AN/ARC-51 UHF radio. The following procedure is used:

Test Equipment
Hewlett-Packard Model 608 signal generator
UHF blade antenna

Test Setup
Set up the blade antenna at some convenient location in front of the airplane. Connect the signal generator to the blade antenna.

Test Procedure

a. Modulate the signal generator with 1000 Hz at 30 percent modulation.

b. Tune the signal generator to the receiver frequency, adjust the output level to just break the squelch, and then increase the level 3 dB. Note the signal generator output level.

c. Turn on the interference source.

d. Increase the output level of the signal generator until the 1000 Hz tone is again audible. Note the output level of the signal generator.

Degradation
The level of degradation in dB is the difference between the two signal generator output levels obtained in steps b. and d.

4.1.2 DATA REDUCTION AND REPORT

All data will be reduced to produce meaningful results and will be chronologically logged by identification of the offender and victim, measured levels of undesirable response, indications of malfunctions, and the interference frequency where applicable. The degree of system degradation will be determined and logged.

This electrical-electronic compatibility demonstration of the XY-2A airplane will be concluded with a report containing test procedures, test data, a technical discussion, and conclusions. The report will be submitted as a data item for contract fulfillment.

4.2 PERSONNEL HAZARDS TEST

Power density measurements of aircraft emitters shall be conducted to determine hazardous areas and to ensure that the possibility of biological injury to personnel from RF radiation in and around the aircraft is minimized or non-existent.

All areas where the power density level is greater than the personnel hazard level (10 mw/cm^2) will be made inaccessible to personnel by roping them off or by setting up barricades. Suitable signs will be posted in these areas declaring them hazardous to personnel.

Measurements of on-board emitters shall be conducted around the perimeter of the aircraft. Levels which exceed ten milliwatts per square centimeter (10 mw/cm^2) for continuous exposure and those exceeding 300 milli-joules per square centimeter per thirty seconds interval (300 mj/cm^2/30 sec) for intermittent exposure are deemed out of specification and hazardous to personnel.

Measurements will be made at a representative number of frequencies for each emitter. Power density measurements will be made with a thermistor-type power meter Narda Model 440 with a proper horn antenna or dipole elements and a directional coupler or attenuator according to frequency band designation. Following is the general method of operation:

a. Connect thermistor to the power meter input by the special cable provided and turn meter on.

b. Set power meter to zero using bias (coarse) and zero (fine) adjustments.

c. Connect equipment as shown in Figure 11. Note: Last connection should be from directional coupler to thermistor; watch for overload on power meter.

d. Orient the pickup antenna for maximum reading on the power meter.

e. Take reading as required.

f. The following is an example:

The information recorded during the measurement was as follows:

Radar frequency – 3250 MHz
Pickup antenna – Waveline horn model 299
Connecting cables – 110 feet of RG-9A/U
Directional coupler – Narda model 3003-20
Power meter – Narda model 440
Meter reading – 1.5 milliwatts

The data reduction follows:

Effective area of pickup antenna at 3250 MHz – 213cm^2
Directional coupler attenuation at 3250 MHz – 20 dB
Cable attenuation at 3250 MHz – 20 dB
Total attenuation + directional coupler attenuation:

40 dB = 20 dB + 20 dB
40 dB = Power ratio of 10^4

$$\text{Power density} = \frac{\text{Power meter} \times \text{meter reading (mW)}}{\text{Effective area of pickup antenna}}$$

$$\text{Power density} = \frac{10^4 \times 1.5\ \text{mW}}{213\ \text{cm}^2}$$

$$\text{Power density} = 70.5\ \text{mW/cm}^2$$

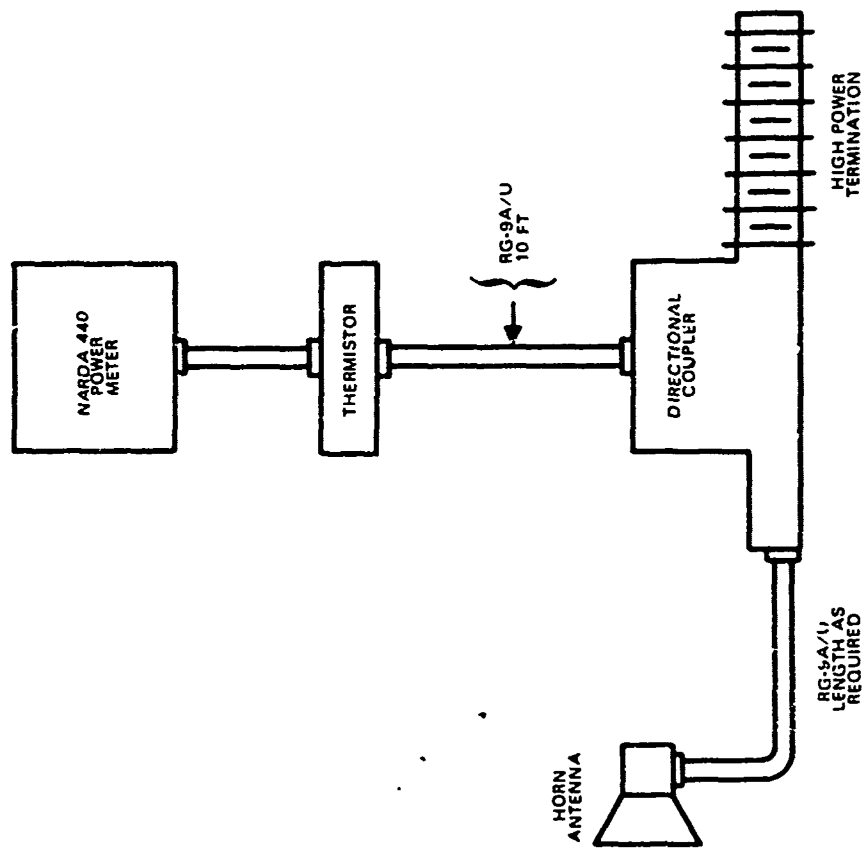


FIGURE 11 MICROWAVE POWER DENSITY MEASUREMENT CONFIGURATION

4.3 ELECTROMAGNETIC HAZARDS TO ORDNANCE TESTS

a. Tests shall be conducted to determine the electromagnetic compatibility between aircraft systems and armament systems and subsystems and hazards from inadvertent ignition by any form of electromagnetic energy at all weapons stations.

b. Measurements are made by monitoring electro-explosive devices (EED) including firing circuits, for electrical transients, stray voltages, and broadband and CW signals that may be induced into the armament system. All offending electrical and electronic equipment listed in Table 7 shall be energized while instrumented EED and firing lines are being monitored. Instrumented EEDs using heat-sensitive tape with appropriate impedance shall be monitored visually throughout the test. Transient, broadband, and CW tests shall be monitored with an NF-105 noise field intensity meter and displayed on a Tektronix 564 memory oscilloscope. The frequencies measured shall be shown on each data sheet. The amplitude of the interference levels detected shall be determined by the signal substitution method, i.e., the detected signal displayed on the oscilloscope will be matched in amplitude by a signal from a calibrated source (impulse generator).

4.4 TEST PROCEDURES

Following are the detailed procedures necessary for equipment operation:

4.4.1 CROSSTALK (CIRCUIT ISOLATION) TEST

With battery for external power, measure the degree of isolation between interphone and receiver circuits. Record results of test on data sheet 8.

a. Setup

1. Open the interphone junction box and block for easy access to the terminal board assembly.
2. Energize interphone on battery or external power during these tests.
3. Place the TRAN SEL rotary switch on the transmitter select panel to transmitter #8 and the ICS switch to ON.

b. Receiver-Interphone Crosstalk

1. Connect the HP 204C (or equal) audio oscillator between pin 5, TB3006, and the junction box ground.
2. Adjust the output of the audio oscillator for 6 V RMS at 1 kHz.
3. Select receiver #1 (HF) on the radio control interphone panel at the pilot's station.
4. Adjust the RAD vol control on the transmitter select panel until the VTVM across the pilot's dummy headset indicates a reference level of 10 dB on the 10 V scale.
5. Turn off receiver #1 select switch and record pilot's dummy headset output.
6. Select receivers 2, 3, 4, and 5 (VHF, UHF, ADF, and TAC) in turn and record the output at the pilot's dummy headset. Also activate ICS on transmitter select panel.
7. Turn off all receiver select switches on the pilot's radio control panel.
8. Repeat steps 3 through 7 for co-pilot and tactical coordinator.
9. Repeat steps 3 through 7 for bombardier-navigator station excluding receivers 4 and 5 (ADF and TAC).

Junction Box Insert Point	Monitor Position						Monitor Position					
	Switch Position	Pilot	Co-Pilot	T-C	B-N	Ext	Switch Position	Pilot	Co-Pilot	T-C	B-N	Ext
AN6ARC-94 Pin 5, TB3006	1						4					
	2						5					
	3						OFF					
AN/ARC-54 Pin 2, TB3006	1						4					
	2						5					
	3						OFF					
AN/ARC-51 Pin 9, TB3006	1						4					
	2						5					
	3						OFF					
AN/ARN-59 Pin 1, TB3001	1						4					
	2						5					
	3						OFF					
AN/ARN-52 Pin 8, TB3003	1						4					
	2						5					
	3						OFF					
AIC-25 Pin 7, TB3006	1						4					
	2						5					
	3						OFF					

DATA SHEET 8 CROSSTALK DATA

10. Connect the HP 204C (or equal) audio oscillator between pin 2, TB3006, and ground of the junction box.
11. Repeat steps 2 through 7 for receiver #2 (VHF).
12. Connect the HP 204C (or equal) audio oscillator between pin 9, TB3006, and ground of the junction box.
13. Repeat steps 2 through 7 for receiver #3 (UHF).
14. Connect the HP 204C (or equal) audio oscillator between pin 1, TB3001, and ground of the junction box.
15. Repeat steps 2 through 7 for receiver #4 (ADF).
16. Connect the HP 204C (or equal) audio oscillator between pin 8, TB3003, and ground of the junction box.
17. Repeat steps 2 through 7 for receiver #5 (TAC).
18. Connect the HP 204C (or equal) audio oscillator between pin 7, TB3006, and ground of the junction box with 6 V RMS signal at 1 kHz.
19. On the transmitter select panel at the pilot's station, select ICS on the TRAN SEL switch. And record the level in dB at the pilot's dummy headset.
20. On the pilot's transmitter select panel, select transmitter #11 and record the output at the pilot's dummy headset; then return to ICS.
21. Select receivers 1, 2, 3, 4 and 5, (HF, VHF, UHF, ADF, and TAC) at the pilot's station and record the dummy headset output in turn.
22. Repeat steps 19 through 21 for co-pilot.
23. Repeat steps 19 through 21 for tactical coordinator (T-C).
24. Repeat steps 19 through 21 for bombardier navigator (B-N) excluding receivers 4 and 5.

c. Private Interphone Crosstalk

1. With equipment set up as described in the preceding paragraph, test the private interphone crosstalk.
2. Connect the audio oscillator (204C or equal) and the dummy microphone to the pilot's station with an audio oscillator output of 250 mv @ 1 kHz.
3. Activate the private communications switches (CPLT, T-C, B-N and EXT) in turn while recording the level at each of the unselected stations; that is, select CPLT and record output at T-C, B-N, and Ext. (Record results on data sheet 9).
4. Repeat steps 2 through 3 with the dummy microphone installed at the co-pilot and tactical coordinator.

4.4.2 BACKGROUND NOISE LEVEL MEASUREMENT

4.4.2.1 Interphone Station Background Noise Level

This test is performed in two phases. The first is the application of each individual load while any increase over the background is recorded on data sheet 10. The second is the application of all loads in an attempt to simulate operational loading conditions, results to be recorded on data sheet 10. The data thus obtained will be used as a reference level for subsequent tests.

4.4.2.1.1 Measurement Procedure

a. Apply power to aircraft and energize the following circuits:

1. Battery
2. A.C., generators #1 and #2
3. Interphone

Communications Between	Monitor Position			
	CP	TC	B-N	EXT
Pilot-Co-Pilot				
Pilot-TC				
Pilot-B-N				
Pilot-Ext				
Co-Pilot-Pilot				
Co-Pilot-TC				
Co-Pilot-B-N				
Co-Pilot-Ext				
TC Pilot				
TC-Co-Pilot				
TC-B-N				
TC-Ext				

DATA SHEET 9 PRIVATE INTERPHONE CROSSTALK DATA

Load	Individual Loads					Cumulative Loads					Pilot				Co-Pilot (CP)				Tactical Coordinator (TC)				Bombardier Navigator (BN)				External			
	Pilot	CP	TC	BN	Ext	Pilot	CP	TC	BN	Ext	CP	TC	BN	Ext	Pilot	TC	BN	Ext	Pilot	CP	BN	Ext	Pilot	CP	TC	Ext	Pilot	CP	TC	BN

DATA SHEET 10 -- INTERPHONE DATA, PHASE I, INDIVIDUAL AND CUMULATIVE LOADS

b. Read the record noise levels at all stations in the following manner:

1. Record in millivolts levels at all stations with all ICS select positions up unkeyed.
2. Monitor pilot's ICS audio and record output level.
3. Monitor co-pilot's ICS audio and record output level.
4. Monitor tactical coordinator ICS audio and record output level.
5. Monitor bombardier-navigator ICS audio and record output level.
6. Monitor external station ICS audio and record output level.

c. Turn on each load, in turns as listed in table 7; read and record per step b; turn off and go to the next load.

d. Repeat steps b and c but leave loads on so that at end of test all loads are on.

4.4.2.2. Receiver Background Noise Load

4.4.2.2.1 Measurement Procedure

a. Apply power to aircraft and energize the following circuits:

1. Battery
2. A.C., generators 1 and 2
3. Interphone

b. The receivers shall be monitored from the pilot's or co-pilot's position. Use data sheet 11 to record data.

c. Background levels

1. AN/ARC-94 background levels

(a) Energize the AN/ARC-94 and allow 3 minutes for warmup.
(b) Select 2 MHz and record receiver output.
(c) Select 6 MHz and record receiver output.
(d) Select 10.1 MHz and record receiver output.
(e) Select 20 MHz and record receiver output.
(f) Turn the AN/ARC-94 off.

2. AN/ARC-54 background levels

(a) Energize the AN/ARC-54 and allow 3 minutes for warmup.
(b) Select 30 MHz and record receiver output.
(c) Select 32 MHz and record receiver output.
(d) Select 48.15 MHz and record receiver output.
(e) Select 68.1 MHz and record receiver output.
(f) Turn the AN/ARC-54 off.

3. AN/ARC-51B background levels

(a) Energize the AN/ARC-51B and allow 3 minutes for warmup.
(b) Select 225.00 MHz and record receiver output.
(c) Select 240.00 MHz and record receiver output.
(d) Select 275.50 MHz and record receiver output.
(e) Select 300.00 MHz and record receiver output.
(f) Turn the AN/ARC-51A off.

Receiver	Frequency	Level	Notes

DATA SHEET 11 RECEIVERS, BACKGROUND LEVELS

4. AN/APX-72 background levels

   (a) Energize the AN/APX-72 and allow 3 minutes for warmup.
   (b) Record receiver output.
   (c) Turn the AN/APX-72 off.

5. AN/ARN-52 background levels

   (a) Energize the AN/ARN-52 and allow 3 minutes for warmup.
   (b) Select CH 1 and record receiver output.
   (c) Select CH 61 and record receiver output.
   (d) Select CH 79 and record receiver output.
   (e) Select CH 126 and record receiver output.
   (f) Turn the AN/ARN-52 off.

6. AN/ARN-59 background levels

   (a) Energize the AN/ARN-59 and allow 3 minutes for warmup.
   (b) Select .190 MHz and record receiver output.
   (c) Select .400 MHz and record receiver output.
   (d) Select .850 MHz and record receiver output.
   (e) Select 1.75 MHz and record receiver output.
   (f) Turn the AN/ARN-59 off.

7. ECM & DECM equipment test shall be conducted as provided in separate classified Addendum A for countermeasures equipment test.

8. AN/ARR-69 background level

   (a) Channel 1
   (b) Channel 7
   (c) Channel 12
   (d) Channel 20

4.4.3 EQUIPMENT TESTS

The test procedures that follow are detailed methods of setting the equipment controls and of operating the equipment under test as well as the test instrumentation. In some tests, specialized test equipment is used to simulate operational conditions.

The results are to be recorded on data sheets 6 and 7. In some cases, special data sheets have been arranged to accommodate the data. Reference is made to paragraph 4.4.2.2.1 for tuned frequencies of tunable receivers. The interference equipment is tabulated in table 7; data sheet 6 gives a complete list.

4.4.3.1 Air Data Computer – ADC

The ADC is susceptible when in normal operation.

a. Set up VPT-10F-11072S (ADC T/S) as follows:

   1. Attach ADC T/S to pitot and static ports of the ADC using the connectors.
   2. Tape the static and total pressure ports of airplane.
   3. Connect corresponding tubes to the pitot and static ports on the back of the ADC T/S.
   4. All knobs on T/S – OFF
   5. Toggle switch – start (30 sec)

6. Altitude dial – proper weight (1.0 K feet)
7. Monitor – altitude meter (1.0 K feet)
8. Rate control – open
9. Airspeed dial – desired airspeed (250 kts)
10. Press – static leak test switch
11. Press – pitot leak test switch

b. Monitor the following for deviations while operating each offending equipment as listed in table 7. Record results on data sheets 6 and 7.

1. True airspeed indicator (TAI) – constant airspeed
2. AAU-19/A altimeter – constant altitude
3. Indicated airspeed (HUD) – constant airspeed

NOTE: HUD Control Panel – "Scales"

4. Advisory panel – No ADC FAIL

c. BITE Test

1. Press BITE switch on ADC box
2. Monitor

(a) Three test lights on ADC box
(1) Should light from bottom up.
(2) Should not take more than 30 sec.

(b) HUD
(1) 400 kts
(2) 4500 feet

(c) TAI
(1) 400 kts
(2) 100 kts (when no bite is run and airplane on ground)

4.4.3.2 Two-Inch Standby Attitude Indicating System

The remote attitude indicating system displays airplane pitch and roll with respect to gravity vertical. This system is susceptible. Monitor the two-inch standby indicator for deviation while interference equipments of table 7 are operated.

4.4.3.3 Angle of Attack System

The angle of attack system is a susceptible and an interference equipment. Operate as a susceptible equipment as follows.

a. Close A of A circuit breakers.
b. Adjust A of A vane for reading of 15 units on A of A indicator.
c. Monitor A of A indicator and angle of attack bracket on HUD display for abnormal movement as the interference equipments of table 7 are operated.

Operate the angle of attack system as an interference equipment as follows:

a. Landing gear handle in WHLS DOWN.
b. Approach indexer dimming knob out of "OFF" position.
c. Adjust A of A vane to cause lights to come on.
d. Operate rudder pedal shaker.

4.4.3.4 AN/ARA-SO/ARR-69 ADF/AUX Receiver

Operate the AN/ARA-50 as a susceptible equipment as follows:

a. Close the following circuit breakers:

AUDIO	AUX RCVR
UHF	ADF
UHF PTT RELAY	

b. Place the selector switch on the audio panel in the AUX REC position.
c. Set the AUX REC switch on the ARR-69 control panel to the ADF position.
d. Place the SIGNAL GENERATOR (HP 608D or TS-498/URR) with the vertical blade antenna about 5 feet directly forward of the aircraft.
e. Set the HEADING MODE switch to the MAN HDG position.
f. Turn the SIGNAL GENERATOR to ON and allow to warm up for 2 minutes. Set the SIGNAL GENERATOR and AUX CHAN of the ARR-69 to the susceptible frequencies listed in paragraph 4.4.2.2.1.c8.
g. The bearing No. 2 pointer on the horizontal situation indicator (HSI) should point to the top lubber line within ±15 degrees.
h. Decrease attenuation of the SIGNAL GENERATOR until the ADF just locks on the signal.
i. Place the HEADING MODE switch to TACAN and MAN HDG and in each position monitor the Bearing No. 2 pointer on the HSI for abnormal movement as the interference equipments of table 7 are operated. Monitor the pointer at each of the frequencies.

Operating procedure for AN/ARC-51B ADF operation is the same as procedure for ARR-69 with these exceptions:

1. AUX REC switch on ARR-69 control panel to CMD position.
2. Set ARC-51B control to MAN and select the frequencies (paragraph 4.4.2.2.1.c3) on the ARC-51B and SIGNAL GENERATOR.
3. Proceed as in steps 8 and 9 of ARR-69 procedure.

4.4.3.5 AN/ASW-25A Data Link

Interference Operation

a. Set the AN/ASW-25A as follows:

1.	TEST/NORM/A-J switch	NORM
2.	ON/OFF AUX ON switch	ON

b. Monitor the susceptible equipment as the switches are thrown.

Susceptible Operation

a. Adjust the SM-511/ASW test set controls as follows:

1.	ACFT ADDRESS	17777
2.	DATA SOURCE	MAN
3.	MSG MIX	EVEN
4.	MSG SPACING	32 MSEC
5.	XMTR POWER	HIGH
6.	XMTR FREQ	310.0 MHz
7.	HIGH PWR CAL	Fully CW

8.	RF ATTEN	0 dB
9.	RECORD LEVEL	5
10.	SCOPE SYNCR.	CONTINUOUS
11.	DATA DC OFF SET	0
12.	R/F DATA MONITOR-RANGE	HIGH
13.	MONITOR FUNCTION	VCC
14.	ODD MESSAGE BITS	0
15.	PARITY	AUTO
16.	DISCRETE WORD	0
17.	ODD LABEL switches 28 thru 32	0
18.	ODD DATA BIT switches 33 thru 69	0
19.	EVEN LABEL switches 28, 29 and 32	0
	30 and 31	1
20.	EVEN DATA BIT switches 34,43,51,60,68	1
	All other switches	0
21.	POWER switch	ON

b. Perform the following aircraft operations:

1. Place the flaps in the down position.
2. Trim the UHT to 3.0 ±0.10 degrees, trailing edge up.
3. Open CB3189 (EMER ϕB PITCH TRIM ACT) to prevent the UHT from drifting off reference.
4. Trim the ailerons to 0 ±0.10 degrees.
5. Place a jumper between pins 12 and 20 of test connector on front of the AFCS roll computer to prevent drift.

c. Set the SM-511/ASW test set controls as follows:

1.	DATA SOURCE	DIAL
2.	MSG MIX	EVEN
3.	MSG SPACING	32 MSEC
4.	VCC/BOTH/VGSE	BOTH
5.	LCC/BOTH/LGSE	BOTH
6.	PARITY	AUTO
7.	EVEN DATA BITS Number 68	1

d. Set the AN/ASW-25 as follows:

1.	Close Data Link circuit breakers	
2.	TEST/NORM/A-J switch	NORM
3.	ON/OFF AUX ON switch	ON
4.	Frequency control switch	310.0 MHz
5.	Converter/receiver (RH MID EQUIP)	17777

e. Depress LDG MASTER function switch.

f. Set the AFCS switches as follows:

STAB ATTD NAV PATH

g. Set the VCC/BOTH/VGSE and LCC/BOTH/LGSE dials to the following positions and note that the UHT, ailerons, and ADI needles respond as follows:

1.	VCC/VGSE	+1.0° UP
	UHT	5.0° ±48′ leading edge down
	ADI vertical needle	UP
2.	LCC/LGSE	+1.0° roll right
	Left aileron	1.0° 30′ ±27′ trailing edge down
	ADI horizontal needle	Right

h. Monitor the UHT, left aileron, ADI horizontal needle, and ADI vertical needle for abnormal deviations as the interference equipments of table 7 are operated. Note if TILT light on the instrument panel illuminates.

i. Return AFCS switches to off position. Disconnect jumper.

4.4.3.6 Doppler Radar System AN/APN-190(V)

Operate the AN/APN-190(V) as a susceptible and an interference equipment as follows:

a. Landing gear up and locked switch – MODE

b. "STBY" MODE
   1. Doppler selector switch – STBY
   2. Doppler memory light – ON
   3. Monitor – Doppler memory light

c. "TEST" MODE
   1. Doppler selector switch – TEST
   2. Doppler memory light – ON for 30 sec and then OFF
   3. Drift angle indicator – 0° (±2°)
   4. Doppler indicator – Ground speed (534.5)
   5. Monitor – Doppler memory light
      – Drift angle indication
      – Doppler indicator

d. "ON" MODE
   1. Doppler selector switch - ON
   2. Doppler memory light – ON
   3. Monitor – Doppler memory light

4.4.3.7 Heading Mode Switch

Operation as a susceptible equipment as follows:

TACAN mode
Monitor the distance indicator and bearing pointer No. 1 on the HSI during the TACAN test of paragraph 4.4.3.10.

MAN HDG mode
Monitor bearing pointer No. 2 on the HSI as the ADF is tested in paragraph 4.4.3.5.

AUTO NAV mode
Monitor the HSI and ADI as the NWDC is subjected to the interference equipments.

4.4.3.8 Radar Beacon AN/APN-154(V)

The radar beacon (AN/APN-154(V)) will be tested for both interference and susceptibility in each of the following modes.

a. AN/APN-154(V)
   1. PWR-STBY-OFF switch – STBY
   2. Mode switch – SINGLE

b. Field tester
   1. ON-OFF switch – ON
   2. Warmup time – 15 minutes

c. AN/APN-154(V)
   1. Power switch – PWR

d. AN/APN 230 radar T/S

   NOTE: The test operation requires that the transmitter frequency and code of the test set will be set to receiver frequency and code of the AN/APN-154(V) under test. Reference equipment tag for AN/APN-154 frequency.

   1. Pressure equalizer value – Two complete turns counterclockwise
   2. Remove coaxial cable W1 and antenna from storage compartment
   3. Connect coaxial cable W1 to antenna and J1 on field tester
   4. Position antenna 50 feet ±2 feet from airplane (Directed toward beacon antenna at an angel of 45° to airplane)
   5. Connect 115 AC 400 Hz power
   6. Tester CAL-OPR-RADAR monitor switch – CAL
   7. PWR set control – Max CW position
   8. Reel voltage control – MAX on PWR IND while slowly rotating PWR set control in CCW direction to maintain an on-the-scale reading of PWR IND meter
   9. RF peaking control – MAX on PWR IND while slowly rotating PWR set control to maintain on-the-scale reading
   10. PWR set control – Until PWR IND needle is on PWR set mark
   11. Adjust frequency meter control until PWR IND meter indicates a maximum meter "dip" deflection and read field tester transmitting frequency directly from frequency meter. REC (8,500 to 9,600 MHz) XMIT (8,800 to 9,500 MHz)
   12. Adjust klystron FREQ INCR control to bring the field tester transmitter operating frequency to the receiving frequency of the beacon under test
   13. CAL-OPR-RADAR monitor switch – OPR
   14. Mode switch – single pulse position
   15. Detune field tester frequency
   16. RF peaking control – max on PWR IND
   17. PWR IND – green portion
   18. Frequency meter control – max PWR IND (Meter "DIP")

e. Repeat d (16) and (17) with mode switch and tester mode switch in DOUBLE 1, 2, 3, 4, & 5 positions

f. Turn on interference sources of table 7 after each mode is selected

g. MONITOR
   1. Meter on APN 230 RADAR T/S
   2. Pin D on P277 with scope (REC VIDEO)

4.4.3.9 AN/ARN-52 TACAN

The ARN-52 TACAN is a susceptible and an interference equipment. Use the URM-101 test set to simulate slant range and bearing signals to the ARN-52. Operate the TACAN as a susceptible equipment as follows:

a. Close ARN-52 circuit breakers
b. Heading mode switch to TACAN
c. TACAN mode switch to T/R. Allow 2 minutes for warmup

NOTE: THE BLOWER MOTOR SHOULD BE RUNNING AT THIS TIME. IF NOT, TURN TACAN MODE TO OFF AND DISCONTINUE TEST UNTIL THE BLOWER TROUBLE HAS BEEN CORRECTED. THE TACAN MUST NOT BE OPERATED FOR MORE THAN 5 MINUTES WITHOUT THE BLOWER OPERATING.

d. Locate test set 10 to 30 feet to right or left of lower TACAN antenna. Attach antenna

NOTE: DO NOT PLACE OPERATING TEST SET CLOSER THAN 10 FEET TO THE TACAN ANTENNA.

e. Power switch on test set to ON. Adjust RF power level to 30 microamperes
f. Channel selector to frequencies listed in paragraph 4.4.2.2.1c(5)
g. Test set range to 100 miles. The distance counter on the HSI is locked on 100 ±1.5 miles. The bearing pointer No. 1 on the HSI reads 140° ±2.5°
h. Pull out TACAN switch-volume control
i. Depress identity switch to KEY position on test set; a 1350 Hz signal can be heard
j. Increase attenuation on URM-101 for minimum signal that bearing and slant range lock-on can be retained
k. Monitor the HSI digital distance readout, bearing pointer No. 1 and course pointer for deviation or malfunction. Monitor audio with headset and audio output meter for interference or malfunction while all interference equipments of table 7 are operated

Operate the TACAN as an interference equipment as follows:

a. Follow above procedure and transmit at these frequencies: 1025 MHz, 1030 MHz, 1040 MHz, and 1075 MHz

4.4.3.10 AN/APX-72 IFF

Operate the AN/APX-72 IFF transponder in modes 1, 2, 3/A, and C to check for susceptibility. Use the 1809/APM-123(V) radar test set to trigger the IFF.

Monitor the ACCEPT and REJECT lights on the radar test set.

Operate the AN/APX-72 as a susceptible and an interference equipment.

a. Preliminary

AN/APX-72

1.	MASTER	OFF
2.	MODES 1, 2, 3/A, & C	OUT
3.	AUDIO	OUT

4.	HOLD A-B-ZERO	A
5.	RAD TEST – MONITOR	OUT

1809/APM-123(V)

1.	FUNCTION	SYSTEM
2.	CODE	0000
3.	LOCK	– – –
4.	ISLS	OFF
5.	PWR	ON

b. Mode 1

AN/APX-70

1.	MASTER	NORM
2.	MODE	1
3.	CODE	73

1809/APM-123(V)

1.	FUNCTION	SYSTEM
2.	CODE	7300
3.	LOCK	– – –
4.	ISLS	OFF
5.	PWR	ON
6.	MODE	1

c. Mode 2

AN/APX-70

1.	MASTER	NORM
2.	MODE	2
3.	CODE	0000

1809/APM-123(V)

1.	FUNCTION	SYSTEM
2.	CODE	0000
3.	LOCK	– – –
4.	ISLS	OFF
5.	PWR	ON
6.	MODE	2

d. Mode 3/A

AN/APX-70

1.	MASTER	NORM
2.	MODE	3/A
3.	CODE	7777

1809/APM-123(V)

1.	FUNCTION	SYSTEM
2.	CODE	7777
3.	LOCK	– – –

4. ISLS OFF
5. PWR ON
6. MODE 3/A

e. Mode C

AN/APX-70
1. MASTER NORM
2. MODE C
3. CODE 0000

1809/APM-123(V)
1. FUNCTION SYSTEM
2. CODE 0000
3. LOCK – – –
4. ISLS OFF
5. PWR ON
6. MODE C

AIR DATA COMPUTER (INTERFERENCE ONLY)
1. SWITCH ADC SELF TEST
2. WAIT 10 SECONDS AND REPEAT
3. MONITOR SUSCEPTIBLE EQUIPMENT

4.4.3.11 AN/ARR-69 UHF Auxiliary Receiver

Operate the ARR-69 as a susceptible equipment as follows:

NOTE: SELECTOR SWITCH ON AUDIO PANEL MUST BE TO NORM.

a. Close the circuit breakers for the ARR-69.
b. Set the function switch on the ARR-69 control panel under AUX REC to CMD. Adjust the VOL and SENS controls to mid-range and allow 2 minutes for warmup.
c. Set the AUX CHAN selector to the following frequencies:
   Channels 1, 7, 12, and 20.
d. Monitor the headset and audio power meter at each channel as the interference equipments of table 7 are operated.

4.4.3.12 AN/ARC-51B UHF Radio and Touch Tune System

The AN/ARC-51B is a susceptible and an interference equipment. Operate the AN/ARC-15B and touch tune system as a susceptible equipment as follows:

a. Push in the AN/ARC-51B, AN/AIC-14, and touch tune circuit breakers.
b. Place the function select switch on the C-8191/ARC touch tune control panel in the TR + G position.
c. Place the mode switch in the FREQ position.
d. Place the C-6567/AIC-14 intercommunication set control in the UHF position.
e. Select frequencies listed in table 10.

Listen in headset for noise while all of the interference equipments of table 7 and 11 are operated.

Monitor the ID-1660/ARC frequency indicator on the upper RH instrument panel for frequency change.

Line	Interference Equipment	Freq (MHz)	Susceptible Equipment	Freq (MHz)	Interaction
		(CH)			
1	AN/ARN-62	(6) 967.00	AN/ARC-51B	370.00	LO vs -3
2		(16)977.00		360.00	LO vs +3
3			AN/ARC-54		None
4			AN/ARC-94		None
5			AN/APN-154		None
6			AN/APN-141		None
7		(1)962.00	AN/APX-72	–	LO vs RF
8			AN/ARN-59		None
9			AN/ASN-91		None
10	AN/ARN-59		AN/ARC-51B		None
179	AN/APX-72	1030	AN/ASW-25	310.00	
180	AN/APN-141	4400	AN/ASW-25	310.00	
181	AN/APN-154		AN/ASW-25	310.00	
182	AN/ARN-52	1017	AN/ASW-25	310.00	
183	AN/ARN-59	1.55	AN/ASW-25	3100	

Notes: nH = Harmonics of the computer clock rate of 750 kHz, where n = 1, 2, 3 ... 11.

nH = Harmonics of 20 kHz shifting pulse, where n = 1, 2, 3... 11.

nH = Harmonics of the 620 kHz Doppler Modulation Frequency, where n = 1, 2, 3 ... 11.

nH = Harmonics of the 1.01 MHz Doppler Modulation Frequency, where n = 1, 2, 3 ... 11.

Table 10 – Receiver Interaction Frequencies

Line	Transmitter	Freq (MHz)	Receiver	Freq (MHz)	Interaction
1	AN/ARC-51B	213.00	AN/ARC-54	34.00	LO vs Image
2		228.00		30.00	2LO vs +2
3		229.95		30.00	LO vs RF
4		230.00		40.00	2LO vs RF
5		235.95		64.00	Image vs +3
6		236.05		78.15	3LO vs -3
7		237.35		30.00	3LO vs +3
8		237.90		66.00	Image vs -3
244		1075	AN/APN-141	4300.	4RF vs LO
245		1030	AN/APX-72	–	RF vs RF
246			AN/ARN-59		None
247			AN/ASN-91		None
248	AN/ARN-52		AN/ASW-25	310.00	None

Source Definitions:

RF = Intentional output of source

2, 3, 4, 5RF = 1st five harmonics of intentional output.

LO, 2, 3LO = Local oscillator input to final mixer and harmonics.

HF, 2, 3HF = Modulated, etc., input to final mixer and harmonics.

Image, 2, 3 Image = Unintentional products of final mixer and harmonics.

Victim Definitions:

RF = Intentional received input

Image, -2, -3, +2, +3 Spurious = Unintentional received input with harmonics of lower and upper injection.

IF = First intermediate frequency.

3H = 3 harmonic of the computer (AN/ASN-78) clock rate.

When a range of frequencies is given, as in the AN/ARN-59, the tuning unit of that particular set should be scanned between the ranges listed.

Table 11 Transmitter-Receiver Interaction Frequencies

Operate the AN/ARC-51B and touch tune system as an interference equipment by executing steps 1 through 5 above and

f. Operate each of the three rocker switches on the touch tune control panel and monitor the susceptible items.
g. Select channel frequency.
h. Operate mike switch and speak into mike. Monitor the susceptible equipment.

4.4.3.13 AN/ASN-99 Projected Map Display System

Operation as an interference equipment:

a. Mode select switch to MAN
b. Slew map right: stop, then slew left using manual slew control.
c. Switch mode select switch to all modes.
d. Engage hold mode and slew map with bullpup controller.

Observe the susceptible equipments for malfunction as steps b, c, and d are performed.

Operation as a susceptible equipment:

a. Mode select switch to N UP.
   Monitor the azimuth ring for deviation from true North. Monitor the center reference symbol for abnormal movement.
b. Mode select switch to NORM.

Monitor ground track alignment with top center lubber line for abnormal movement while operating offending equipments of table 7.

4.4.3.14 AN/ASN-91(V) Navigation/Weapon Delivery Computer

4.4.3.14.1 Program Tape Loading

The NWDC will be loaded with the most current operational flight program (OFP). This will be accomplished using the control and display unit (CADU).

4.4.3.14.2 Susceptible Operation

After the OFP has been successfully loaded, the NWDC will sequence the IMS through a complete pretake-off erection and alignment as described in paragraph 4.4.3.15.4 steps a through g.

a.	Present position switch	LAT-LONG
b.	Mode selector	PRES-POS
c.	Air data computer	ON
d.	IMS	INERTIAL
e.	Insert 175 knots of tailwind	
f.	Doppler radar	ON
g.	HUD	ON
h.	Master function switch	NAV
i.	Actuate weight off gear switch	
j.	Operate the interference equipments of tables 7 and 11 and monitor the computer caution light and the computer fail flag on the NWDC.	

4.4.3.14.3 Interference Operation

Turn the NWDC on and monitor the susceptible equipments.

4.4.3.15 AN/ASA-90 Inertial Measurement Set

4.4.3.15.1 General

The inertial measurement set (IMS) is considered to be a susceptible equipment.

> CAUTION: THE IMS IS DESIGNATED TO OPERATE WITH CONDITIONED AIR SUPPLIED AT ALL TIMES TO THE INERTIAL MEASUREMENT UNIT (IMU) OPERATION WITHOUT CONDITIONED AIR IN AMBIENTS BELOW 100° F IS PERMISSIBLE AND LIMITED OPERATION IN AMBIENTS ABOVE 100° F IS POSSIBLE. IF THE IMU AMBIENT IS ABOVE 100° F, THE FOLLOWING TABLE OF TIME OF PERMISSIBLE OPERATION SHALL BE FOLLOWED OR CONDITIONED AIR MUST BE SUPPLIED TO THE IMU.

AMBIENT TEMPERATURE	MAX OPERATING TIME
110° F	2 hours
120° F	1 hour
130° F	0.5 hour
Above 130° F	No operation allowed

4.4.3.15.2 Operation as a Susceptible Equipment

Operate the IMS in the computer modes (GND ALIGN, NORM, INERTIAL), and in the backup modes (MAG SL GRID) to check for susceptibility.

4.4.3.15.3 Backup Modes

a. Mode control to MAG SL
b. MAG VAR/LATITUDE to EN
c. Operate interference sources of table 7
d. Monitor the following and record results:

   HSI, ADI, HUD

4.4.3.15.4 Computer Modes

The following steps should be taken to check the IMS in the computer modes:

a. IMS mode control - GND ALIGN
b. MAG-VAR to desired magnetic variation GND ALIGN light is illuminated

NOTE: INSURE BOTH COOLING FANS ARE OPERATING.

c. NAV/WD computer "ON"
d. Enter present position
e. After 2 minutes, IMS-FAIL light "OFF"
f. Manual Fail Indicator on Adapter/P.S. is not tripped
g. After approximately 9.5 minutes – GND ALIGH light "OUT"
h. Operate interference equipments of table 7 and note that GND ALIGN light goes out in 9.5 minutes
i. Mode control to "NORMAL" - Monitor NWDC panel
j. Operate interference equipment of table 7 and record data
k. Mode control to "INERTIAL" - Monitor NWDC panel
l. Operate interference sources of table 7 and record data

CAUTION: WAIT TWO MINUTES BEFORE SWITCHING FROM OFF TO GND ALIGN (OR ANY OTHER MODE) AFTER JUST PREVIOUSLY HAVING IMS IN GND ALIGN (SEQUENCE IS: OFF-GND ALIGN-OFF-WAIT 2 MINUTES-GND ALIGN-OFF-WAIT – – – ETC.) THIS SEQUENCE IS IMPORTANT SINCE FAILURE TO WAIT MAY DAMAGE THE IMS.

4.4.3.16 AN/AVQ-7(V) Head Up Display

The AN/AVQ-7(V) head up display (HUD) is considered to be a susceptible and an interference equipment. The HUD presentation is in accordance with the setting of the master function switch (MFS). The MFS is a group of pushbuttons located on the instrument panel that places the aircraft in a desired navigational, attack, or landing mode by interfacing the proper equipments necessary to perform the desired operation. All of the seventeen HUD symbols shown in Figure 10 are displayed by placing the navigation/weapon-delivery system in the attack mode navigation/terrain following mode, and landing mode. Monitor each symbol displayed for jitter or sudden abnormal movement, since this is considered a malfunction of the HUD or of the equipment controlling the movement of the symbol. The symbols are monitored while the interference equipments of table 7 are turned on. Perform the following steps to display the various symbols and operate the HUD as a susceptible equipment.

CAUTION: THE HUD SHALL NOT BE OPERATED WHEN THE HUD HOT LIGHT ON THE CAUTION PANEL IS ILLUMINATED. IF THE HUD HOT LIGHT ILLUMINATES, THE HUD SHALL BE TURNED OFF. CONDITIONED AIR SHALL BE SUPPLIED AT 32°F AT A FLOW RATE OF 0.7 POUND/MINUTE TO THE ELECTRONIC UNIT.

THE HUD SYSTEM SHALL BE OFF DURING SWITCHING OF EXTERNAL POWER.

THE HUD BRIGHTNESS CONTROL SHALL NOT BE POSITIONED TO FULL BRIGHTNESS FOR LONGER THAN IS REQUIRED TO CHECK THE BRIGHTNESS POSITION.

a. Engage the circuit breakers.
b. Apply power to the HUD by turning the HUD OFF/BRT control one-half of a revolution. Position the SCALES/OFF switch to the SCALES position.
c. Select the aircraft NAV mode by deselecting all of the master mode pushbuttons (NORM ATTACK, OFFSET, RADAR BOMB, NAV BOMB, TF, LDG). A pushbutton is deselected if the button is not illuminated. Monitor the symbols displayed in Figure 12.
d. Select the terrain following mode by pushing the TF pushbutton. Monitor the symbols displayed in Figure 12.
e. Select the landing mode by pushing the LDG pushbutton. Monitor the symbols displayed in Figure 12.
f. Select RADAR BOMB, NORM ATTACK, and NAV BOMB modes separately and monitor the symbols displayed in Figure 12 in each of three modes.

Operate the HUD as an interference equipment by performing the following steps.

a. Turn power to HUD off and on using the HUD brightness control. Leave power ON.
b. Switch panel lights on and off.
c. Standby reticle on and off, and rotate.
d. Scales on, and off.

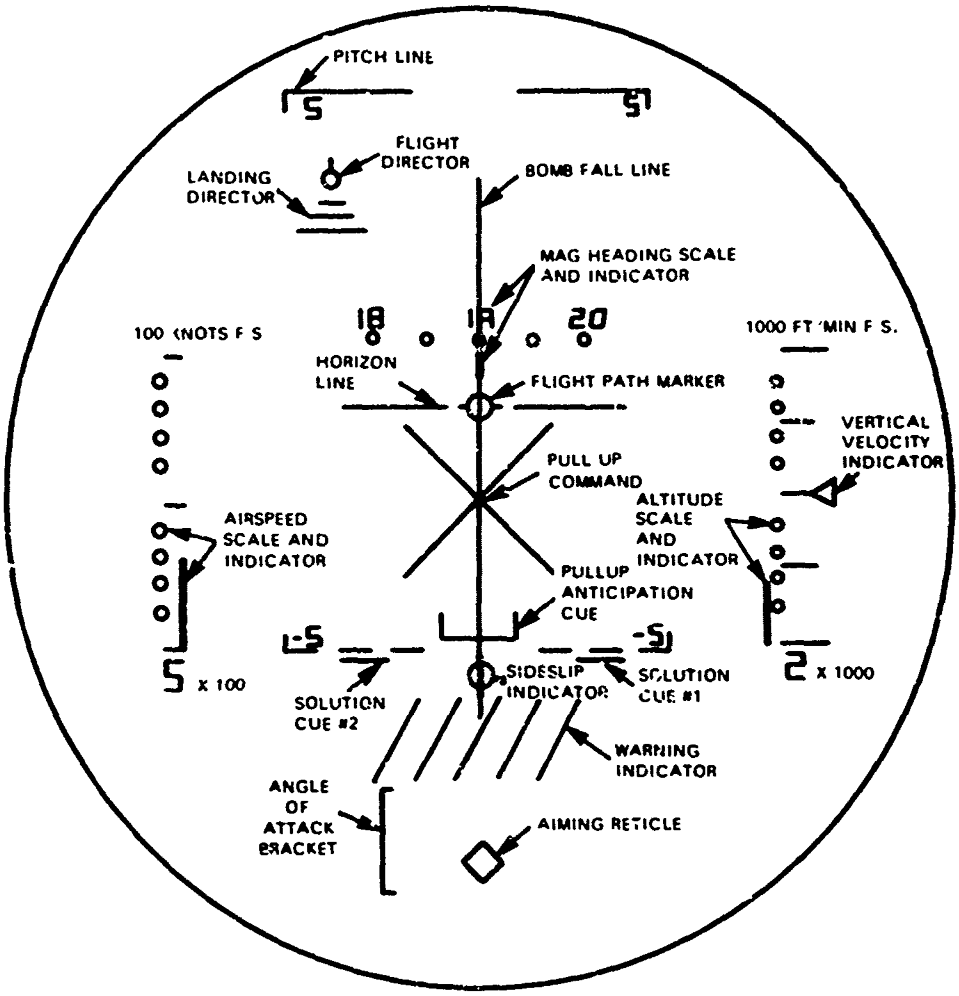


FIGURE 12 HUD SYMBOLOGY

e. Self-test on and off.
f. Rotate filter control.
g. Rotate standby reticle depression control.

4.4.3.17 Forward Looking Radar (FLR) (AN/APQ-126)

The FLR will be tested in the following modes for susceptibility and interference. Transmitter/receiver interaction frequencies will be contained in classified Addendum E.

a. GENERAL

1. NORM-OFF-LOAD Sw -- NORM position
2. Close the circuit breakers.
3. Install eccosorb over FLR antenna.
4. Energize interference equipment of table 7 while monitoring modes listed below.

b. MODE TESTS

1. Beacon mode (BCN)

(a) Radar mode switch - BCN
(b) Master function switch -- MAN HDG
(c) Monitor radar indicator

(1) Indicator display -- ±45°
- Depressed center PPI
- Uniform size
Centered on tube
Intensity uniform
(2) Fail light -- Off

(d) Range change switch 80, 40, 20, 10, 5 miles

2. Terrain avoidance (TA)

(a) Radar mode switch - TA
(b) Master function switch MAG HDG
(c) Monitor radar indicator

(1) Indicator display ±45°
Depressed center PPI
Uniform size
Centered on tube
Intensity uniform
(2) Fail light Off

(d) Range/reject switch 5 and 10 miles

3. Ground mapping pencil beam (GMP)

(a) Radar mode switch GMP
(b) Master function switch MAN HDG
(c) Monitor radar indicator

(1) Indicator display ±45°
Depressed center PPI

- Uniform size
- Centered on tube
- Intensity uniform

(2) Fail light – Off

(d) Range change switch – 80, 40, 20, 10, 5 miles

4. Ground mapping shaped beam (GMS)

(a) Radar mode switch – GMS
(b) Master function switch – MAN HDG
(c) Monitor radar indicator

(1) Indicator display – ±45°
- Depressed center PPI
- Uniform size
- Centered on tube
- Intensity uniform

(2) Fail light – OFF

(d) Range change switch – 80, 40, 20, 10, 5 miles

5. Air-to-ground ranging (AGR)

(a) Radar mode switch – AGR
(b) Master function switch – MAN HDG
(c) Tilt control – "0"
(d) Monitor radar indicator

(1) Indicator display – Single vertical trace
- Centered on tube
- Range strobe will continually search

(2) Fail light – OFF

6. Terrain following (TF)

(a) HUD – ON (2 min warmup)
(b) Radar mode switch – GMS
(c) Master function switch – TF
(d) Norm-off-load switch – NORM
(e) TER CLR – 200 feet
(f) Monitor radar indicator

(1) Indicator display – E^2 type
Test pulse above right end

(2) Fail light – OFF

(g) Monitor ADI horizontal needle
- Steady value (CLIMB)
- No warning flag

(h) Monitor HUD TF symbology
Climb command indicated
No warning signals displayed

7. Cross scan ground map pencil – (CS GMP)

   (a) Radar mode switch – GMP
   (b) Master function switch – TF
   (c) Monitor radar indicator

      (1) Indicator display – ±20°
        – Depressed center PPI
        – Uniform size
        – Centered on tube
        – Intensity uniform
      (2) Fail light – OFF

   (d) Range change switch – 5 and 10 miles
   (e) Monitor ADI horizontal needle
        – Steady value (CLIMB)
        – No warning flag

   (f) Monitor HUD TF symbology
        – Climb command indicated
        – No warning signals displayed

8. Cross scan terrain avoidance (CSTA)

   (a) Radar mode switch – TA
   (b) Master function switch – TF
   (c) Monitor radar indicator

      (1) Indicator display – ±20°
        – Depressed center PPI
        – Uniform size
        – Centered on tube
        – Intensity uniform
      (2) Fail light – OFF

   (d) Range change switch – 5 and 10 miles
   (e) Monitor ADI horizontal needle
        – Steady value (CLIMB)
        – No warning flag
   (f) Monitor HUD TF symbology
        – Climb command indicated
        – No warning signals displayed

4.4.3.18 ASCU

The ASCU is a susceptible and an interference equipment. Energize interference equipments of table 7 while monitoring modes listed below for abnormal response.

a. BITE OPERATION

   1. ASCU weapon type switches – WAK
   2. Landing gear handle – Down
   3. FLR – STBY
   4. Shrike switch – ADI
   5. MASTER ARM SWITCH – ON
   6. ARM safety disable switch – Momentarily activate

7. BIT switch – Actuate and hold
8. Monitor lights ("GO" or "NO GO")

   (a) Both "GO" and "NO GO" lights come on.
   (b) After 14 sec one light goes out.
   (c) ASCU passes if "GO" stays on.

NOTE: BITE test should not be conducted with MER or TER installed or safety pin inserted.

b. MANUAL BOMB

1. Select following

(a)	Land/carrier	LAND
(b)	Weight on gear	Weight off gear
(c)	Doppler	Unreliable
(d)	ADC	Reliable
(e)	Landing gear handle	Up
(f)	Gear up and locked switch	Up and locked
(g)	Heading mode	AUTO NAV
(h)	Computer power	PWR
(i)	HUD brightness	(ANY)
(j)	IMS control	MAG SLAVE
(k)	Fuzes	ON

2. ASCU weapon type switches — XFK
3. Radar altitude – 2000 feet
4. True airspeed – 300 knots
5. IMS – ZERO TILT
6. Settings on armament release Panel

   (a) Singles
   (b) Quantity – 01
   (c) Interval – 100 (ANY)

7. Settings on armament select panel

   (a) Select stations – 1, 2, 3, 6, 7, and 8
   (b) Fuze – NOSE and TAIL
   (c) Master arm – ARM

8. Armament release button -- Press
9. One station ready light goes out for each press

c. MANUAL RIPPLE

1. Select following

(a)	Weight on gear	Weight off gear
(b)	Doppler	Unreliable
(c)	ADC	Reliable
(d)	Landing gear handle	Up
(e)	Master function switch	NAV
(f)	Heading mode	AUTO NAV
(g)	Computer power	PWR

(h)	HUD brightness	(ANY)
(i)	IMS control	MAG SLAVE
(j)	Gear up and locked switch	Up and locked
(k)	Fuzes	ON

2. ASC weapon type switches – XFK
3. Radar altitude – 2000 feet
4. True airspeed – 300 knots
5. IMS – ZERO TILT
6. Settings on armament release panel

   (a) PAIRS
   (b) QUANTITY – 12
   (c) INTERVAL 100

7. Settings on armament select panel

   (a) Select stations – 1, 2, 3, 6, 7, and 8.
   (b) Fuze – NOSE and TAIL
   (c) Master Arm – ARM

8. Armament release button – Press
9. Station ready lights – OUT

d. NORMAL BOMB

1. Select following

(a)	Land carrier	Land
(b)	Weight on gear	Weight off gear
(c)	Doppler	Unreliable
(d)	ADC	Reliable
(e)	Landing gear handle	Up
(f)	Heading mode	AUTO NAV
(g)	Computer power	PWR
(h)	HUD brightness	(ANY)
(i)	IMS control	MAG SLAVE
(j)	Gear up and locked	Up and Locked
(k)	Fuzes	On

2. ASCU weapon type switches — XFK
3. Radar altitude – 2 K feet
4. True airspeed – 300 knots
5. IMS – ZERO TILT
6. Master function switch – NORMAL ATTACK
7. Settings on armament release panel

   (a) PAIRS
   (b) QUANTITY (6)
   (c) INTERVAL (100)

8. Settings on armament select panel

   (a) Select stations - 1, 2, 3, 6, 7, and 8
   (b) Fuze – NOSE and TAIL
   (c) Master arm – ARM

9. Slew aiming reticle, using Bullpup controller, down bomb fall line until it intersects the 5° pitch line.
10. Designate button (on PSG) – Press
11. Armament release button – Press and hold until solution cue passes below FPM.
12. First release occurs when the solution cue overlaps FPM.

e. NORMAL OFFSET

1. Select following

(a)	Weight on gear	Weight off gear
(b)	Doppler	Unreliable
(c)	ADC	Reliable
(d)	Landing gear handle	Up
(e)	Heading mode	AUTO NAV
(f)	Computer power	PWR
(g)	HUD brightness	(ANY)
(h)	IMS control	MAG SLAVE
(i)	Gear up and locked	Up and locked
(j)	Fuzes	ON

2. ASCU weapon type switches – XFK
3. Radar altitude – 2 K feet
4. True airspeed – 300 knots
5. IMS – ZERO TILT
6. Master function switch – NORMAL ATTACK AND OFFSET
7. Settings on armament release panel

   (a) PAIRS
   (b) QUANTITY (6)
   (c) INTERVAL (100)

8. Settings on armament select panel

   (a) Select stations – 1, 2, 3, 6, 7, and 8
   (b) Fuze – NOSE and TAIL
   (c) Master arm – ARM

9. Slew aiming reticle, using Bullpup controller, down bomb fall line until it intersects the 5° pitch line.
10. Designate button (on PSG) – Press
11. Armament release button – Press and hold until solution cue passes below FPM.
12. First release occurs when the solution cue overlaps FPM.

f. NAV BOMB

1. Select following

(a)	Weight on gear	Weight off gear
(b)	Doppler	Unreliable
(c)	ADC	Reliable
(d)	Landing gear handle	Up
(e)	Heading mode	AUTO NAV

(f)	Computer power	PWR
(g)	HUD brightness	(ANY)
(h)	IMS control	MAG SLAVE
(i)	Gear up and locked	Up and locked
(j)	Fuzes	ON

2. ASCU weapon type switches – XFK
3. Radar altitude – 2 K feet
4. True airspeed – 300 knots
5. IMS – ZERO TILT
6. Master function switch – NAV BOMB
7. Settings on armament release panel

    (a) PAIRS
    (b) QUANTITY (3)
    (c) INTERVAL (100)

8. Settings on armament select panel

    (a) Select stations – 1, 2, 3, 6, 7, and 8
    (b) Fuze – NOSE and TAIL
    (c) Master arm – ARM

9. Select destination via N panel
10. HUD

    (a) Range 30 nmi: No A/R, BFL indicates required steering
    (b) Range 30 nmi: A/R appears over target but cannot be driven
    (c) Range 10 nmi: A/R can be driven

11. FLR

    (a) Range > 10 nmi: Radar cannot be driven
    (b) Range ≤ 10 nmi: Radar works as in normal attack

12. Slew aiming reticle, where range ≤10 nmi, down bomb fall line until it intersects the 5° pitch line.
13. Armament release button – Press and hold until solution cue passes below FPM.
14. First release occurs when the solution cue overlaps FPM.

g. RADAR BOMB

1. Repeat steps (1–5) of normal bomb
2. Master function switch – Radar bomb
3. Repeat steps (7–8) of normal bomb
4. Slew, using Bullpup controller, until radar cursors overlay the target.
5. Designate button (on PSG) – Press
6. A/R appears over target
7. Armament release button – Press and hold until solution cue passes below FPM
8. First release occurs when the solution cue overlaps FPM.

h. RADAR OFFSET BOMB

1. Repeat steps (1–5) of normal bomb

2. Master function switch – RADAR BOMB and OFFSET
3. Repeat steps (7–8) of normal bomb
4. Slew, using Bullpup controller, until radar cursors overlay the I.P.
5. Designate button (on PSG) – Press
6. The aiming reticle moves to target
7. Radar cursors remain on I.P.
8. At range $\leq$ 60,000 feet FLR goes to AGR
9. Displays same as normal bomb
10. Armament release button – Press and hold until solution cue passes below FPM.
11. First release occurs when the solution cue overlaps FPM.

4.4.3.19 Radar Altimeter AN/APN-141(V)

The radar altimeter is a susceptible and an interference equipment. Proceed with the operation as follows:

a. Control knob – Clockwise (set on)
b. Allow 3 minutes to warmup
c. Set altitude limit index marker – so that "OFF" flag is out of sight.
d. Monitor off flag and needle for abnormal response while operating interference equipment of tables 7 and 11.

4.4.3.20 Shrike Weapon Circuitry

WARNING: ALL ARMAMENT AND SUPPLEMENTARY RACKS MUST BE REMOVED FROM THE AIRPLANE AND ALL CARTRIDGES REMOVED FROM THE MAU-9A/A BOMB RACKS BEFORE BEGINNING TESTING.

The Shrike weapon circuitry is a susceptible and an interference equipment.

Susceptible operation

a.	ASCU weapon select station 1	WBR
b.	Connect the SHRIKE adaptor harness, 218-97701, to station 1 pylon and the adapter to the SHRIKE disconnect.	
c.	Verify all armament switches and master function switches are deselected.	
d.	MASTER ARM	DEPRESS
e.	ARM SAFETY DISABLE	ACTUATE
f.	Set the armament release panel as follows:	
	1. RELEASE MODE	SINGLES
	2. QUANTITY SELECT	01
g.	Station 1	DEPRESS
h.	SHRIKE advisory light	ILLUMINATED
i.	AN/ASM-149 test set	ON
j.	Test set SELECTOR switch	5
	1. SHRIKE switch	ADI
	2. Test set meter	0 Region
k.	Monitor ADI and test set meter needle for abnormal movement as interference equipments	

of tables 7 and 11 are operated.

l. Test set SELECTOR switch — 10

m. Monitor test set meter needle as the interference equipments are operated. A fire malfunction occurs if the needle swings into the 0 region.

4.4.3.21 A/A24B-4(V) Aircraft Monitor and Control

Interference operation

a. Close the 11 AMAC circuit breakers.

b. Switch the option selector switch from OFF through MONITOR, SAFE, ARM and back to OFF.

c. Operate delivery mode switches as follows:

1.	Retard/freefall	RET to FF to RET
2.	Ground/air	GRD to AIR to GRD
3.	TA/TB	TA to TB to TA
d.	EMER/SAFE	EMER to SAFE to EMER
e.	LAMP TEST	OFF to ON to OFF

f. Monitor the susceptible equipments as steps b through e are performed.

4.4.3.22 Bullpup Radio Transmitting Set (ARW-77)

The Bullpup will be operated in the following manner for both susceptibility and interference. Energize interference equipments of tables 7 and 11 while monitoring modes listed below for abnormal response.

a. Station 1 weapon selector switch YBP or YBS

b. Master arm switch - ON

c. Armament disable switch - Momentarily actuate

d. Transmitter crystals - Install

e. Single/pairs/simult - SINGLES

f. Set up TS - 2022/ARM-23

1. Power switch OFF
2. Five circuit breaker (Top of crystal warmup compartment) - Closed
3. Attach P105 to power in receptable J4 on control panel.
4. Attach P106 to ARW-77 test connector.
5. Install crystal
6. Meter FCN switch #5
7. Meter M-2 Value (8 10)
8. Meter FCN switch #6 and #7
9. Meter M-2 Value (8 10)
10. Power switch ON
11. Five shielded panel lights Light
12. T/S self-test

(a) Press lamp test/77 launch switch four red command indicators should light

(b) Indicator switch day

(c) Press lamp test/77 launch switch -- four white command indicators should light.
(d) Command channel – NEVT
(e) Left and right command indicators – light

g. Connect test antenna 293-9295629 to TAC RCVR receptacle J9 on T/S
h. Antenna – in front of duct lip

NOTE: The crystals require at least 5 minutes to warmup after power is applied.

i. RCVR (TIS) – TAC
j. ACC (TIS) - NORMAL
k. Command channel (T/S) – NEUT
l. Select station #1
m. Bomb button – Press and release
– L & R command indicators on
n. Command channel – DN/R
o. Bullpup controller – Up, down, left, and right
– Note appropriate command indicator

NOTE: The transmitter will transmit for approximately 45 seconds. It may be reset by turning station #1 off and back on and pressing the bomb button again.

p. Post test procedure

1. Power switch – OFF
2. Secure T/S
3. Remove crystals
4. Return crystals to confidential storage

4.4.3.23 Walleye Weapon Circuitry

The Walleye weapon circuitry is susceptible and interference equipment. Susceptible and interference operation is as follows:

a. Set weapon system as follows:

1.	Master arm	ON
2.	Armament safety disable	Actuate
3.	ASCU weapon select station 1	YBK

b.	AN/APQ-126	STANDBY
c.	Radar mode switch	NORMAL

d. Connect the Walley missile to station 1 pylon using the Walleye adapter harness.
e. Select station

1. Walleye advisory light illuminated.
2. Station 1 light green.

f. Adjust radar indicator controls for best picture.
g. Monitor picture for malfunctions as the interference equipments of tables 7 and 11 are operated.

WARNING: BEFORE TESTING, ALL ARMAMENT AND SUPPLEMENTARY RACKS MUST BE REMOVED FROM THE AIRCRAFT AND ALL CARTRIDGES REMOVED FROM THE MAU-9A/A BOMB RACK.

4.4.3.24 Sidewinder and Auxiliary Jettison

The Sidewinder and auxiliary jettison are susceptible and interference equipments. Energize interference equipment of tables 7 and 11 while monitoring modes listed below.

NOTE: All armament and supplementary racks must be removed from the airplane and all cartridges removed from the MAU-9A/A bomb racks before beginning tests.

SIDEWINDER

a. ASCU switches

   1. Stations (1, 2, 3, 6, 7, and 8) – WAL
   2. Stations (4 and 5) – A

b. Release mode switch – SINGLES.
c. Connect the test set (213-17020-1)
d. Connect audio generator to station 1 connection (J1) on test set.
e. IR cool switch – On (Depressed)
f. Master arm switch – On (Depressed)
g. Arm safety disable switch – Actuate
h. Station select switches 1 and 8 – On
i. Ground interlock switch for 1 and 8 on T/S – On
j. Monitor

   1. Station select lights 1 and 8 – Green
   2. Master arm light – Green
   3. Master arm lights 1 and 8 on T/S – On
   4. Headset – Audio tone
   5. Sidewinder light – On
   6. Following T/S lights

      (a) Stations 1 and 8 ϕA 115 VAC – On
      (b) Stations 1 and 8 ϕB 115 VAC – On

k. Bomb Button – Depress (Hold)
l. Monitor T/S lights

   1. Disc firing light (station 1) – On
   2. Bullpup guided firing light (Station 1) – On
   3. Camera control light – On

m. Bomb button – Release
n. Monitor T/S lights

   1. Disc firing lights (Station 1) – Off
   2. Bullpup guided firing light (Station 1) – Off
   3. Camera control light – Off

AUXILIARY JETTISON

o. LH gear up and locked switch Up and locked
p. Auxiliary jettison switch – Actuate
q. Monitor T/S lights

   1. Aux firing (Station 1) – On
   2. Bullpup unguided firing (Station 1) – On

r. Auxiliary jettison switches – Release
s. Monitor T/S lights

1. Aux firing (Station 1) – Off
2. Bullpup unguided firing (Station 1) – Off

4.4.3.25 ALQ-100 Countermeasures

NOTE: This procedure is classified and is thus found in Addendum A.

4.4.3.26 APR-25/27 Radar Homing and Warning

NOTE: This procedure is classified and is thus found in Addendum A.

4.4.3.27 Dispenser (AN/ALE-29A)

a. The dispenser is a susceptible and an interference equipment. Operate as follows for susceptibility test.

1. Control knob – BOTH
2. Monitor

(a) Counter 1 – number of chaff packets in forward dispenser
(b) Counter 2 – number of chaff packets in aft dispenser

3. Set knobs (Programmer)

(a) BURSTS – 4
(b) BURST INTERVAL – .2
(c) SALVOS – 32
(d) SALVOS INTERVAL – 2

4. Turn on all interference equipment of table 7

b. The interference test is conducted as follows:

1. Repeat steps 1, 2, and 3 of susceptibility test
2. Press center of control knob – Fires chaff
3. Monitor susceptible equipment

4.4.3.28 Automatic Flight Control System

The AFCS will be checked in the attitude mode with heading engaged and then with navigation engaged. It is necessary that the mode switch on the IMS control panel be placed in the magnetic slave position. This supplies the needed inputs to the HSI, which then provides inputs to the AFCS. For this test, external hydraulic power must be applied to the aircraft. The positions of the AFCS control switches should first be "STAB," "ATTD," "HDG," and "ALT"; then "STAB," "ATTD," "NAV," and "ALT." While the AFCS is in the two modes, the AFCS warning lights should be extinguished. The control surfaces and roll, pitch, and yaw actuator indicators should be monitored for abnormal or sudden movement as the offending equipments of tables 7 and 11 are operated.

4.4.3.29 Pitch and Roll Trim System

With external hydraulic power applied to the aircraft, set pitch and roll trim to zero degrees by activating the pitch and roll trim switch on the pilot's stick grip. The trim indicator on the left-hand slant panel should be monitored for abnormal deviation while the offending equipments of table 7 are operated.

4.4.3.30 ASN-54(V) Approach Power Compensator

a. The approach power compensator is both a susceptible and an interference equipment. Operate as follows for the test.

   1. Switch "engage" switch through OFF, ON, OFF, ON.
   2. Cycle temperature through COLD, STD and HOT.

b. Susceptible operation

   1. Install protractor and pointer at actuator output shaft.
   2. Attach the phase sensitive demodulator to pins 10 and 1 of test connector J301. This allows monitoring and recording of actuator voltage.
   3. Simulate landing gear down/weight off gear condition.
   4. Set angle of attack vane to 17.5 ±.5 units.
   5. Throttle friction — Minimum friction
   6. Fuel control switch — NORMAL
   7. Set the APC controls as follows:

      (a) Temperature switch as necessary
      cold 40°F STD 80°F HOT

      (b) Engage switch — ON

   8. Monitor output of actuator for abnormal movement as the interference equipments of table 7 are operated.

4.4.3.31 Nose Gear Steering

The nose gear steering is an interference item. The nose wheel may be steered with the rudder pedals when the steering switch on the control stick is closed. The nose gear is centered automatically by the actuator when the arresting hook is not up and locked. Perform the following steps to operate the nose gear steering as an interference source:

a. Engage circuit breakers.
b. If the airplane is on wing jacks, place the weight-on-gear switch, located in the LH wheel well, to the engaged position.
c. Depress the steering button on the pilot's stick grip, depress the right and left rudder pedals and observe the susceptible equipments as this is done.

4.4.3.32 Camera KB-18

a. The camera is both a susceptible and an interference equipment. Operate it as an interference source as follows:

   1. ASCU weapon type switches - WBK all stations
   2. Master arm - ON
   3. Arm safety disable - Operate
   4. Stations selected - minimum of one station
   5. Set camera control unit ASI switch to -200
   6. Set camera control unit overrun switch to -4 second
   7. Operate bomb switch on control stick and verify operation of camera unit.
   8. Camera will run as long as bomb button is depressed. When button is released, the camera will run for 4 seconds after release.

b. Operate the test for susceptibility as follows:

   1. Install breakout cable in camera connector line at the camera unit.

2. Connect a phase sensitive voltmeter to pin 2 of breakout cable.
3. Install cover on photocell sensor on camera unit to prevent light from interfering with test.
4. A3CU weapon selector WBK
5. Arm safety disable – Operate
6. Station selected – minimum of one
7. Operate interference equipment listed in table 7 and monitor phase sensitive voltmeter for a level change.

4.4.3.33 AN/ARC-94 High Frequency Transmitter/Receiver

The AN/ARC-94 is both a susceptible and an interference equipment.

a. Energize the AN/ARC-94 and allow three minutes for warmup
b. Place the HF monitor switch on the ICS to the ON position.
c. Monitor the frequencies listed in paragraph 4.4.2.2.1c while energizing interference equipment of tables 7 and 11.
d. Record data on data sheets 6 and 7.
e. See paragraph 4.4.4.1 for receiver versus receiver test.
f. See paragraph 4.4.4.2 for transmitter versus receiver test.

4.4.3.34 AN/ARC-54 VHF FM Transmitter/Receiver

The AN/ARC-54 VHF FM set is both a susceptible and an interference equipment.

a. Energize the AN/ARC-54 and allow three minutes for warmup.
b. Place AN/ARC-54 control to the T/R mode.
c. Place the FM monitor switch on the ICS to the ON position.
d. Monitor frequencies listed in paragraph 4.4.2.2.1c(2) while energizing interference equipment listed in tables 7 and 11.
e. Record data on data sheets 6 and 7.
f. See paragraph 4.4.4.1 for receiver versus receiver test.
g. See paragraph 4.4.4.2 for transmitter versus receiver test.

4.4.3.35 AN/ARN-59 LF Automatic Direction Finder

The AN/ARC-59 is both a susceptible and an interference equipment.

a. Energize the AN/ARC-59 and allow three minutes for warmup.
b. Operate the LS/ADF in each of the following modes.

   ADF
   ANT
   LOOP

c. Place the MON switch on the ICS control to LF/ADF.
d. Monitor the frequencies listed in paragraph 4.4.2.2.1c(6) while energizing interference equipment listed in tables 7 and 11.
e. Record data on data sheets 6 and 7.
f. See paragraph 4.4.4.1 for receiver versus receiver test.
g. See paragraph 4.4.4.2 for transmitter versus receiver test.

4.4.3.36 Lightning Protection Test

The test procedure for lightning protection tests is contained in Addendum B.

4.4.3.37 Precipitation Static Test

The test procedure for precipitation static (P-static) tests is contained in Addendum C.

4.4.3.38 Static Discharger Test

The test procedure for testing of static dischargers is contained in Addendum D.

4.4.4 AVIONICS INTERFERENCE TESTS

4.4.4.1 Receivers vs Receivers Test

4.4.4.1.1 The test frequencies to be used in this test were chosen to specifically test spurious outputs and responses of the receivers installed in the airplane.

a. Receivers as a source of interference are examined for spurious output of the first local oscillator.

b. The spurious responses of receivers were calculated by use of the relationship:

$$f_{sp} = \frac{pf_{LO} \pm f_{IF}}{q}$$

where

f_{sp} = frequency of spurious response

p,q = positive integers

f_{LO} = frequency of the first local oscillator

f_{IF} = operating frequency of the first IF amplifier

4.4.4.1.2 The following constitutes the test of receiver interaction.

a. Apply power to airplane and energize the following circuits:

1. Battery
2. AC, generators 1 and 2.
3. Interphone
4. Receivers as required in table 10.

b. Monitor the "victim" receiver and tune the "source" receiver per table 10. Record resulting measured level on data sheet 12.

4.4.4.2 Transmitters versus Receivers Test

4.4.4.2.1 The test frequencies to be used in this test were chosen in the same manner as the prior test for the receivers. (Step b, paragraph 4.4.4.1.1.) The transmitter outputs investigation includes:

a. First order spurious

1. Mixer input frequency
2. Local oscillator frequency
3. Image (spurious mixer product)

b. Harmonics through the fifth.

4.4.4.2.2 The following constitues the test of transmitters to receivers interaction test.

a. Apply power to ship and energize the following circuits:

Line	Interference Equipment	Frequency	Susceptible Equipment	Frequency	BNL	Measured Level	Remarks

DATA SHEET 12 RECEIVER INTERACTION

1. Battery
2. AC, generators 1 and 2
3. Interphone
4. Transmitters and receivers as required in table 11.

b. Install dummy microphone assembly in co-pilot position. Adjust the HP-204C (or equal) audio oscillator for an output of 50 millivolts at 400 Hz. If interference is encountered change the modulation to 1 kHz and record results.
c. Set up each transmitter for transmission at the listed frequency (see table 11) from the co-pilot's position. Monitor the victim receiver at the pilot's position. Record results on data sheets 6 and 7.

4.4.4.2.3 The interference detected during this test shall be examined to determine the manner of interference, i.e., the interference induced in the power or other interconnecting wires. The following procedure shall be used.

a. Transmit, as during the above test, and record the change in receiver output.
b. Terminate the receiver (at the equipment) in a proper load, simulating the normal antenna.
c. Transmit and record as in step a, above.
   1. If there is no change in receiver output caused by the transmission, the interference is entering the receiver via the antenna.
   2. If there is a change, the interference is entering the receiver through interconnecting wires or the receiver case.
d. Terminate the transmitter (at the equipment) in a proper load simulating the normal antenna.
e. Transmit and record as in step a, above.
   1. If there is no change (and one did occur in step c, above), the interference is radiating from the transmitting antenna.
   2. If there is a change, the interference is radiating from the transmitter case or interconnecting wires.
f. Replace normal antenna on receiver and transmit as in step a, above. If there is a change and there was none in step c, above, the interference is radiated from the transmitter case or interconnecting wiring and entering the receiving antenna.

4.4.4.2.4 Further determination of impact and/or character of interference defined here is deferred until the in-flight portion of the testing.

4.4.4.3 Intermodulation Test

The intermodulation measurement provides an undesired signal produced in a receiver or transmitter as a result of the mixing of two or more off-channel signals in a nonlinear device.

4.4.4.3.1 Measurement

The measurements are made by radiating two or more undesired signals to the victim equipment and measuring the resultant quieting or signal modulation at the victim receiver output. The generated intermodulation frequencies will be calculated using any two possible operational transmitter frequencies at a time. Figure 13 shows the test setup. The following formula gives the relationships required to produce such responses.

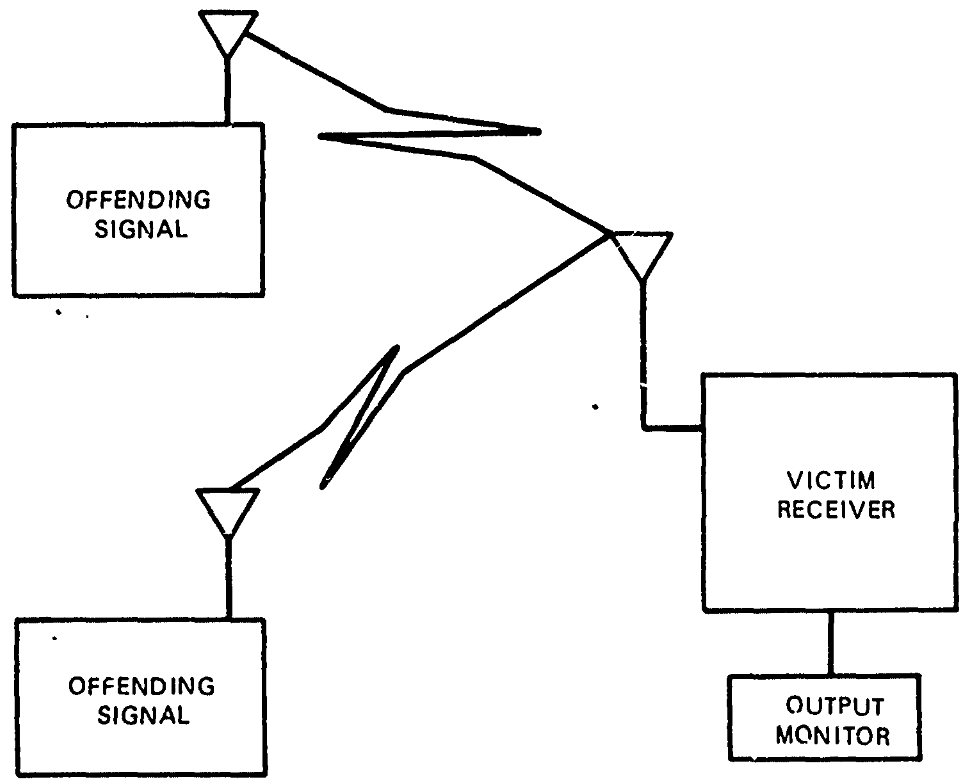


FIGURE 13 INTERMODULATION TEST SET UP

$$f_o = mf_a \pm nf_b$$

where

f_o is the tuned frequency of the receiver

f_a is the frequency of the interfering source nearest to f_o

m is an integer giving the multiple of f_a involved

f_b is the other interfering source frequency

n is an integer giving the multiple of f_b involved.

The measurements to be performed under this test will be concentrated on second order, positive and negative combinations:

$$f_o = f_a + f_b$$

and $f_o = f_a - f_b$,

third order negative:

$$f_o = 2f_a - f_b$$

and $f_o = f_a - 2f_b$

and fifth order negative:

$$f_o = 4f_a - f_b$$
$$f_o = 3f_a - 2f_b$$
$$f_o = 2f_a - 3f_b$$
$$f_o = f_a - 4f_b$$

Transmitter frequencies and receiver response frequencies will be identified in terms of response characteristics of each receiver, and resultant test data will be recorded on data sheet 13.

4.4.4.4 Cross Modulation Test

Cross modulation is the transfer of amplitude modulation from an interfering signal to the desired signal. Cross modulation occurs when both the desired signal within the receiver passband and the undesired signal are simultaneously present in a nonlinear device. The nonlinear device may be the receiver mixer stage or the RF stage. Often the RF stage is operating in a nonlinear manner because of overloading by a strong interfering signal.

Cross modulation differs from intermodulation in that a desired signal must be present. While each type of interference involves two signals, in the case of intermodulation neither signal is a desired signal at the operating frequency.

When cross modulation occurs, the interfering signal is usually close in frequency to the desired signal or strong enough to overcome front end selectivity. Adjacent channel, upper and lower, and image frequency interfering signals should be investigated.

Test Procedure

a. Apply power to airplane and energize the following circuits:

1. Battery
2. AC generators 1 and 2
3. Interphone

DATA SHEET 13 INTERMODULATION TEST				
Airplane:	Name: Date:	Meter:		
Intermodulation Equation	f_o MHz Receiver Equipment	f_a MHz Trans. Equipment	f_b MHz Trans. Equipment	Receiver Output level
$f_o = f_a - f_b$	29.5 AN/ARC-94	57.5 AN/ARC-54	28.0 AN/ARC-94	
$f_o = 2f_a - f_b$	29.5 AN/ARC-94	30.0 AN/ARC-94	30.5 AN/ARC-54	
$f_o = f_a - 2f_b$	29.5 AN/ARC-94	60.5 AN/ARC-54	15.5 AN/ARC-94	
$f_o - 2f_a - f_b$	30.5 AN/ARC-54	30.0 AN/ARC-54	29.5 AN/ARC-94	
$f_c = f_a - 2f_b$	30.5 AN/ARC-54	60.5 AN/ARC-54	15.0 AN/ARC-94	
$f_o = 4f_a - f_b$	29.5 AN/ARC-94	15.0 AN/ARC-94	30.5 AN/ARC-54	
$f_o = 3f_a - 2f_b$	31.5 AN/ARC-54	30.5 AN/ARC-54	30.0 AN/ARC-94	
$f_o = 2f_a - 3f_b$	31.0 AN/ARC-54	30.5 AN/ARC-54	10.0 AN/ARC-94	
$f_o = f_0 - 4f_b$	31.0 AN/ARC-54	39.0 AN/ARC-54	2.0 AN/ARC-94	

4. Transmitters and receivers as required

b. Install dummy microphone assembly in co-pilot position. Adjust the HP-204C audio oscillator for an output of 50 millivolts at 1 kHz.

c. Modulate interfering signal transmitter with 400 Hz signal. Desired signal will be unmodulated. Tune interfering signal transmitter around frequency shown on data sheet while monitoring receiver for response (Figure 14).

d. Set up each receiver transmitter combination for operation at the listed frequency. Monitor the victim receiver at the pilots position while operating the interfering receiver. Record results on data sheet 14.

4.4.5 TRANSMITTER – RECEIVER INTERACTIONS FLIGHT TEST

All instances of transmitter-receiver interactions caused by cable or case leakage are tested in flight. These are identified during the transmitter-to-receiver interaction test (4.4.4.2.2). Record repeated in-flight frequency tests on data sheet 15.

5.0 TEST REPORT

Results of the test will be presented in a formal test report in compliance with MIL-E-6051C.

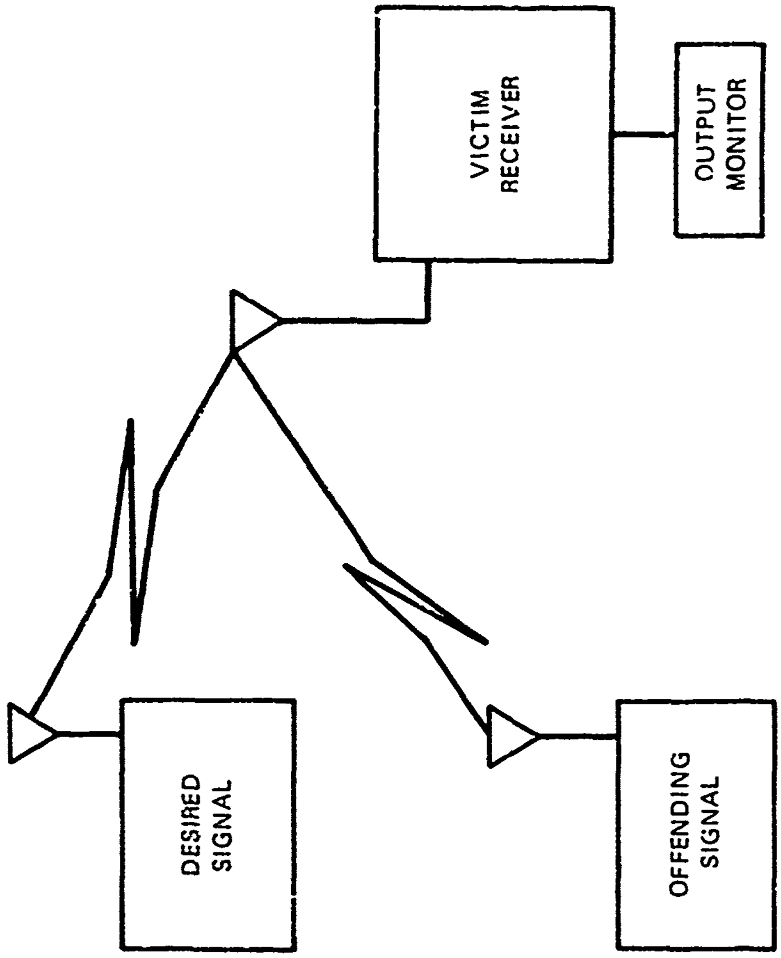


FIGURE 14 CROSS MODULATION TEST SET UP

DATA SHEET 14 CROSS MODULATION TEST				
Airplane:	Name:		Meter:	
	Date:			
Equipment Desired Signal	Desired Signal Frequency MHz	Equipment Interfering	Interfering Signal Frequency MHz	Result Output, MV.
AN/ARC-54	30.0	AN/ARC-94	30.05	
AN/ARC-54	30.0	AN/ARC-94	34.0	
AN/ASW-25	310.0	AN/ARC-51B	309.95	
AN/ASW-25	310.0	AN/ARC-51B	310.05	
AN/ASW-25	310.0	AN/ARC-51B	333.40	

Line	Source Transmitter	Frequency	Victim Receiver	Frequency	BNL	Measured Level	Remarks

DATA SHEET 15 IN-FLIGHT TEST OF TRANSMITTER, RECEIVER INTERACTION

ADDENDUM A

OF

APPENDIX C

TO

NAVAIR EMC EDUCATIONAL MANUAL

ECM EQUIPMENT TESTS

Addendum A will contain the test procedures for the ECM equipment; AN/APR-25, AN/APR-27, and the AN/ALQ-100.

ADDENDUM B

OF

APPENDIX C

TO

NAVAIR EMC EDUCATIONAL MANUAL

LIGHTNING TESTS

Addendum B will contain the details of the lightning tests. This may include a discussion of scale model tests to prove safety of external stores, fuel tanks, radomes, canopies, navigation lights, fuel dump, wiring, explosives, weapons, and cable runs. Government or contractor facilities may be used for these tests.

ADDENDUM C

OF

APPENDIX C

TO

NAVAIR EMC EDUCATIONAL MANUAL

PRECIPITATION STATIC TESTS

Addendum C will contain the test procedures for tests to verify adequacy of the contractor's design features to assure that P-static will not limit system performance.

ADDENDUM D

OF

APPENDIX C

TO

NAVAIR EMC EDUCATIONAL MANUAL

DISCHARGER TESTS

Addendum D will contain a description of test procedures to assure the effectiveness of static dischargers both as to design and installation practice.

ADDENDUM E

OF

APPENDIX C

TO

NAVAIR EMC EDUCATIONAL MANUAL

TEST FREQUENCIES

FOR

CLASSIFIED EQUIPMENT

Addendum E will contain the frequency tables that will be used for frequency selection during the tests which involve the security classified equipment. This addendum will carry a security classification and will be bound separately from the test plan for convenience in handling.

ADDENDUM F

OF

APPENDIX C

TO

NAVAIR EMC EDUCATIONAL MANUAL

GENERAL ACCEPTANCE TEST

Addendum F will contain the test procedure for the general acceptance test. Each production airplane will be given a limited test to ensure production compliance with the EMC requirements.

ADDENDUM G

OF

APPENDIX C

TO

NAVAIR EMC EDUCATIONAL MANUAL

INTERSYSTEM COMPATIBILITY TEST

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INTERSYSTEM COMPATIBILITY TEST

1. Introduction

The intersystem test will be conducted to determine the electromagnetic spectrum signature (radiated emission and susceptibility) of the aircraft weapon system of each individual electronic equipment or subsystem and an overall spectrum signature of the weapon system as operated during a simulated mission.

The analysis and prediction study, previously conducted, will be used to channel the test into potential problem areas. This will save time in that only the frequency ranges and equipment modes of operation that have a potential emission or susceptibility will be explored. The tests will be operated according to tables prepared for each test. These tables will be prepared using the results of the analysis and prediction study.

The intersystem compatibility test will be divided into two parts:

a. Radiated emission measurement
b. Radiated susceptibility measurement

2. Radiated Emission Measurements

The radiated emission test will measure the frequency and field strengths of the signals and spurious radiations from the electrical and electronic subsystems and equipments. The measurements will be made using each of the four test antenna positions as shown in Figure G-1 unless the instructions modify this requirement. This portion of the intersystem test will consist of the following:

a. Single source emission
b. Simulated mission emission

2.1 Single Source Emission Test

This part of the test will be conducted according to the list of table G-1. The preparation of this table will be based on the results of the analysis and prediction study previously conducted. It will list each equipment to be tested and will give details of the test such as frequency range to be scanned, modes of operation, frequency setting, and position of functional controls. The Remarks column will be used to refer to detailed data to be recorded on data sheet 7. This detailed data will show frequencies and radiated power levels.

2.2 Simulated Mission Emission Test

This part of the test will be conducted by operating the system according to the mission schedule of table G-2. The preparation of this table will reflect the results of the analysis and prediction study. The simulated emission will exercise the various equipment and subsystems in function, frequency, and operational mode to demonstrate potential problems. Measurements will be made in the frequency ranges indicated in the table, and the Remarks column will be used to refer to detailed data recorded on data sheet 7. The information on this data sheet will include measured frequencies, radiated power levels, and test antenna positions.

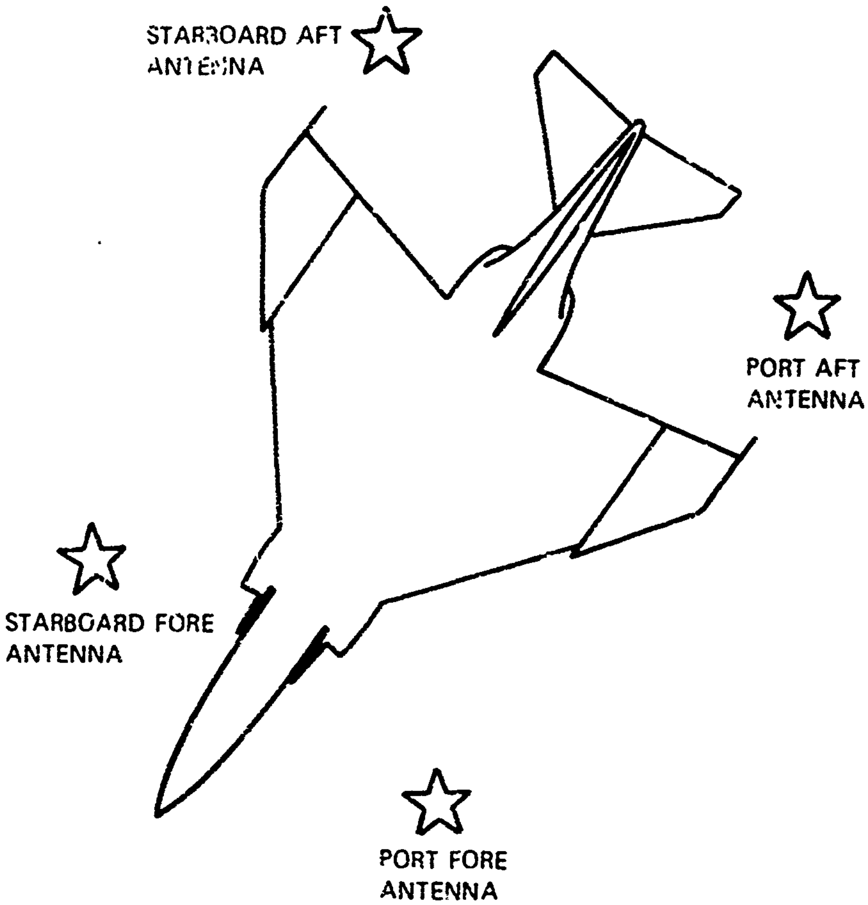


FIGURE G-1 ANTENNA POSITIONS FOR RADIATED EMISSION AND RADIATED SUSCEPTIBILITY TESTS

SOURCE EQUIPMENT/SUBSYSTEM					RADIATED EMISSION	
TEST NO.	NOMENCLATURE	FREQUENCY	FUNCTION	OPERATIONAL MODE	FREQUENCY RANGE	REMARKS

TABLE G-1 – Single Source Radiated Emission Test Operation

		SOURCE EQUIPMENT/SUBSYSTEM				RADIATED EMISSIONS	
TEST NO.	MISSION PHASE	NOMENCLATURE	FUNCTION	FREQUENCY	OPERATIONAL MODE	FREQUENCY RANGE	REMARKS

TABLE G-2 – SIMULATED MISSION RADIATED EMISSIONS TEST OPERATION

3. Radiated Susceptibility Measurements

The radiated susceptibility part of the intersystem test will be conducted to determine the frequencies and environmental field strengths that will cause a specified degree of degradation of performance of the equipments and subsystems. These measurements will be made using each of the four test antenna positions as shown in Figure G-1, unless the specific instructions modify this requirement. This portion of the intersystem test will be divided into two parts:

a. Equipment/susbsystem test
b. Simulated mission test

3.1 Equipment/Subsystem Test

The equipment subsystem portion of the radiated susceptibility test will determine the susceptibility of each equipment and subsystem to an external electromagnetic environment. This test will be conducted by operating and monitoring the equipment and subsystems while subjecting it to the electromagnetic environment specified in table G-3. The table will be based on the results of the analysis and prediction study and will list all equipments and subsystems which will be potential victims in an intersystem compatibility situation. Frequencies, modulation characteristics, and electromagnetic environmental field strengths will be specified and susceptibility thresholds of each equipment and subsystem will be established for each mode of operation. The power level at test antenna terminals will be based on antenna directivity and power gain and the relative position and distance to the victim antenna so that the field strength will be that present in the region of the victim antenna. This may be accomplished by actual measurement with a field strength meter.

A column headed "Effect" is provided in table G-3 to record test results. This will be done by reference to data sheet 7, which will be used for detailed data on each susceptible response.

3.2 Simulated Mission Test

The simulated mission part of the radiated susceptibility test will determine the susceptibility of the aircraft weapon system to a predetermined external electromagnetic environment during each phase of the simulated mission. The system will be operated according to the mission schedule of table G-4. The instructions regarding frequency, modulation characteristics and field strengths will be based on the analysis and prediction study. Multiple signals will be used in some phases of the test to explore potential intermodulation problems.

Susceptibility will be noted in the column headed "Effect" in table G-4 by reference to detailed data recorded on data sheet 7. The data will show the susceptibility threshold, frequency, and field strength calculated or measured at the victim equipment antenna location.

	ELECTROMAGNETIC ENVIRONMENT			VICTIM EQUIPMENT				EFFECT
TEST NO.	FREQUENCY RANGE	POWER LEVEL	MODULATION	FUNCTION	NOMENCLATURE	FREQUENCY	OPERATIONAL MODE	

TABLE G-3 – EQUIPMENT/SUBSYSTEM RADIATED SUSCEPTIBILITY SUBTEST

	Electromagnetic Environment				Victim Equipment/Subsystem				
TEST NO.	SIMULATED MISSION PHASE	FREQUENCY RANGE	POWER LEVEL	MODULATION	FUNCTION	NOMENCLATURE	FREQUENCY	OPERATIONAL MODE	EFFECT

TABLE G-4 – SIMULATED MISSION RADIATED SUSCEPTIBILITY TEST

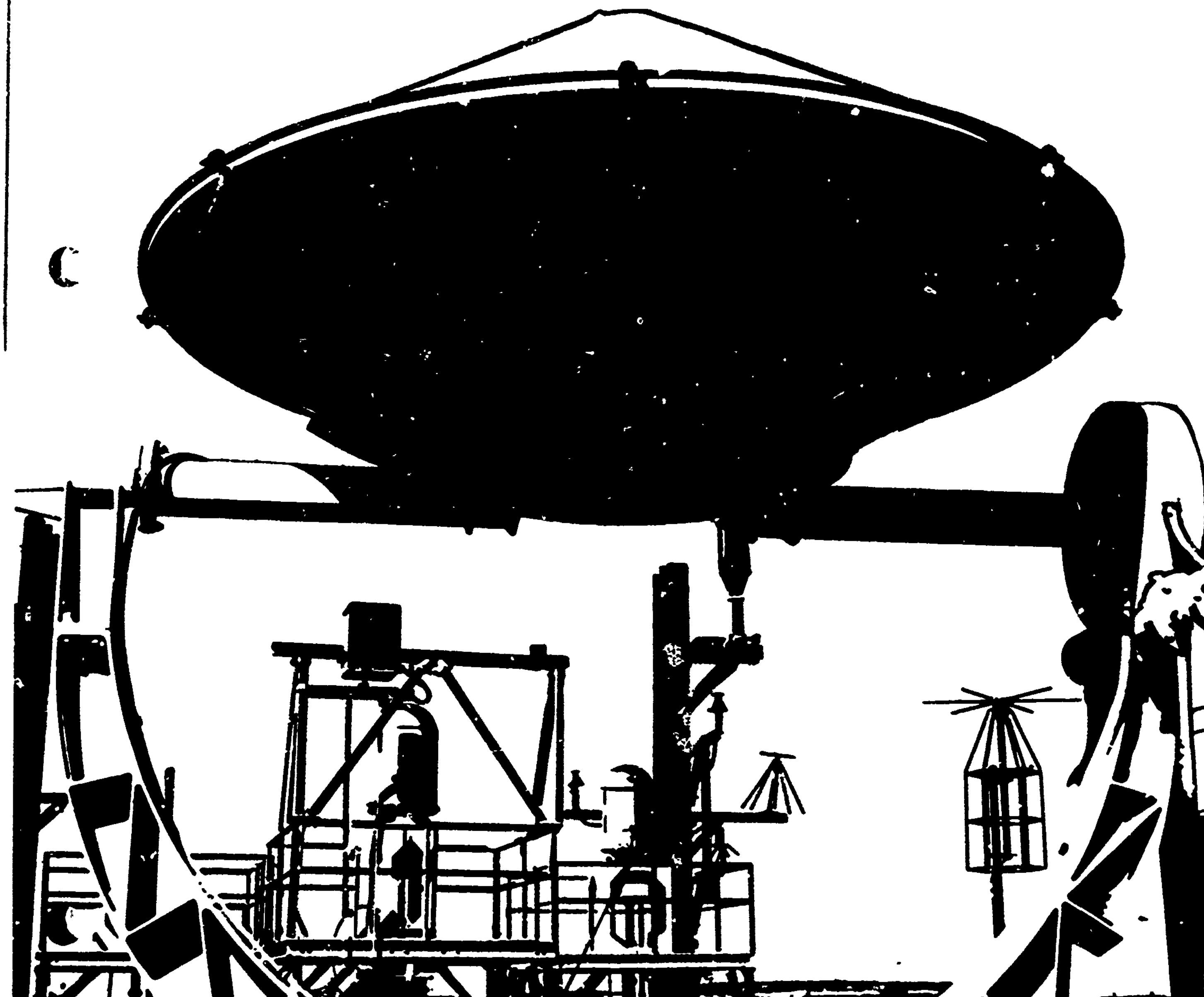
NAVAIR 5335

NAVAL AIR SYSTEMS COMMAND

ELECTROMAGNETIC COMPATIBILITY MANUAL

APPENDIX D

SAMPLE EMI TEST PLAN FOR A COMPONENT, EQUIPMENT OR SUBSYSTEM



PUBLISHED BY DIRECTION OF COMMANDER, NAVAL AIR SYSTEMS COMMAND

APPENDIX D

SAMPLE EMI TEST PLAN FOR A COMPONENT, EQUIPMENT OR SUBSYSTEM

PREFACE

This EMI test plan is a typical test plan for a component, equipment, or subsystem which must meet the requirements of MIL-STD-461 using the measurement procedures of MIL-STD-462. It has been included as an appendix to the NAVAIR EMC Educational Manual to be used as a model for the test plan for a similar component, equipment, or subsystem. When the procurement contract calls for compliance to MIL-STD-461 and MIL-STD-462, this type of test plan must be prepared by the contractor. Approval of the test plan shall precede the start of formal testing. Section 4.3 of MIL-STD-461A, entitled EMI/EMC Test Plan, states that the test plan details the means of implementation and application of the test procedures necessary to verify compliance with the EMI/EMC requirements contained in the Standard. The minimum information to be included in the test plan is outlined in the same section.

The procuring agency or the contractor may find it necessary to tailor MIL-STD-461 testing requirements by deleting or adding tests not on the schedule for equipment of this class or subclass. Tailoring may also include a change in limits and/or a modification of the frequency range of measurements. In addition, performance criteria to be used in the susceptibility tests will be established.

The test plan, when approved by the procuring agency, constitutes a contractual agreement with the contractor stating that all EMC requirements of the contract will be met when the equipment has passed each test according to the test plan.

Performance information (frequencies, power, sensitivity) given here is fictitious and does not apply to particular equipments. This eliminates the necessity of placing a security classification on this document.

ELECTROMAGNETIC INTERFERENCE TEST PLAN

For the
LONGHORN COMMUNICATION, INC.
COMPUTER DISPLAY SYSTEM
MODEL 7511

In Accordance With
CONTRACT NO 263-71-A-7926

TEST PLAN NO. TP 7-5084
8 November 1970

REVISED 14 DECEMBER 1970
REVISED 24 JANUARY 1971

SMITH TECHNOLOGY CORPORATION
TESTING FACILITY
1234 Main Street
GLEN LYON, PENNSYLVANIA 20705

PREPARED BY: ______________________
W. A. D. Walter, SENIOR EMI ENGINEER

APPROVED BY: ______________________
J. P. Eckert, MANAGER EMC GROUP

ELECTROMAGNETIC INTERFERENCE TEST PLAN

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ILLUSTRATIONS

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ELECTROMAGNETIC INTERFERENCE TEST PLAN

FOR COMPUTER DISPLAY SYSTEM MODEL 7511

1.0 INTRODUCTION

1.1 SCOPE

This test plan describes the criteria required for measurement of electromagnetic emission and susceptibility characteristics of the Computer Display System (CDS) manufactured by Longhorn Communication Inc. (Navy Contract No. 263-71-A-7926) in accordance with MIL-STD-461 and MIL-STD-462.

1.2 PURPOSE

The purpose of the electromagnetic interference (EMI) tests is to measure levels of conducted and radiated interference emitted from the system. The test results will be compared with the specified limits of MIL-STD-461 and MIL-STD-462 and the applicable criteria of LC-35950-06.

1.3 EMI TESTS

The computer display system is classified in Class IC of Table I, MIL-STD-461A. Accordingly, the test requirements are given in Table II of MIL-STD-461A and are listed in Table I of this test plan.

2.0 APPLICABLE DOCUMENTS

The following documents are applicable to the preparation and performance of the EMI tests discussed.

2.1 MILITARY STANDARDS

MIL-STD-461A	Electromagnetic Interference Characteristics Requirements for Equipment, 10 March 1969
MIL-STD-462	Electromagnetic Interference Characteristics Measurement of, 1 August 1968
MIL-STD-463	Definitions and System of Units, Electromagnetic Interference Technology, 9 June 1966
MIL-STD-831	Test Reports, Preparation of

2.2 MILITARY SPECIFICATIONS

MIL-C-45662	Calibration of Standards

2.3 LONGHORN COMMUNICATIONS, INCORPORATED, DOCUMENTS

LC 35950-06	Acceptance Criteria for Computer Display System, Model 7511
LC 46789-01	Test Requirements for Computer Display System, Model 7511
Drawing 6234-1	Wiring and Cabling Diagrams for Computer Display System, Model 7511

3.0 TEST SITE

3.1 EMI TEST FACILITY

All EMI tests will be performed in a shielded enclosure at the Smith Technology Corporation EMI Test Facility, 1234 Main Street, Glen Lyon, Pennsylvania.

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TYPE OF EMI TEST	MIL-STD-461 DESIGNATION	TEST PLAN PARAGRAPH NUMBER
Conducted Emission	CE01 (AC power lines)	6.2.1
	CE02 (control & signal lines)	6.2.2
	CE03 (AC power lines)	6.2.1
	CE04 (control & signal lines)	6.2.2
Radiated Emission	RE01 (magnetic field)	6.3.1
	RE02 (electric field)	6.3.2
	(T) RE04 (magnetic field)	6.3.3
Conducted Susceptibility	CS01 (power lines)	6.4.1
	CS02 (power lines)	6.4.2
	CS06 (power lines, spike)	6.4.3
Radiated Susceptibility	RS01 (magnetic field)	6.5.1
	RS02 (magnetic induction)	6.5.2
	RS03 (electric field)	6.5.3

Table 1 – EMI TESTS

3.1.1 TEST FACILITY DESCRIPTION

The shielded room is a class AA enclosure. Dimensions are 24 feet by 36 feet by 10 feet high. It is fabricated of 4-foot wide steel panels MIG-welded at the seams. The door is of the pocket sliding type and is 7 feet high by 6 feet wide. Shielding continuity at the door edges is provided by the inflation of a pneumatic tube in the periphery of the door. This presses the door skin against the door frame. A tin coating on the mating surfaces assures a low contact resistance.

3.1.2 POWER FACILITIES

The following power facilities are available in the shielded room:

A. 208/120 volts, 100 amperes, 3 phase 60 hertz
B. 208/120 volts, 100 amperes, 3 phase, 400 hertz
C. 28 volts, 60 amperes, direct current

All power-line filters are on the outside wall of the room. A removable signal line penetration plate is available and may be custom fabricated for any special penetration configuration.

3.1.3 SHIELDING CHARACTERISTICS

Electric field attenuation of the shielded room exceeds 120 dB from 1 kHz to 10 GHz. The magnetic field attenuation is 10 dB at 20 Hz and increases to 120 dB at 10 kHz. Earth reference is provided by a driven ground rod.

3.1.4 GROUND PLANE

The computer display system will be mounted on a copper ground plane during all tests. The coppler plane is 2.25 square meters in area and is 1.6 mm thick. It is bonded to the wall of the shielded room at intervals of 60 cm, and the minimum width is 76 cm.

3.1.5 GROUNDING

The computer display system will be installed in the shielded room in a way that will simulate the final installation, with particular attention to the grounding scheme. To minimize ground loops, systems ground will be accomplished at one point. Each measuring equipment and ancillary component will also be grounded at only one point. The computer will use power from phase 1, and the measuring instrumentation will be powered from phase 2.

3.1.6 AMBIENT ELECTROMAGNETIC PROFILE

Measurements will be made of radiated and/or conducted ambient electromagnetic levels before each EMI test so that measured values may be compared with ambient levels. These data will be provided in the test report.

4.0 TEST CONFIGURATION

Figures 1 and 2 show the computer display system and support equipment configuration in the shielded room. These figures indicate the approximate location of the equipment within the room. Reasonable variations of this configuration will be made at the discretion of the cognizant EMI test engineer.

5.0 TEST SAMPLE

5.1 DESCRIPTION

The computer display system provides a simultaneous readout of a minimum of any 3 of the 21 computer data acquisition system words and the 3-time reference system words selected. This readout is used in the flight control center as a primary system performance monitor during preflight testing and simulated flight. The CDS receives from the ground station the data acquisition system words, time reference system words and the computer modes in binary format and displays this information in either decimal or octal format as selected by the operator. The CDS is arranged in 2 racks as shown in Figure 3.

5.2 OPERATIONAL MODES

The CDS function switch has 4 positions:

OFF

STANDBY

OPERATIONAL

TEST

EMI testing will be performed with the CDS functioning in the OPERATIONAL mode.

5.2.1 CONTROL SETTINGS

For each test performed the display group controls will be set as stated below.

A. Computer/TRS word: Computer word 15
B. Decimal/octal: Decimal
C. Reset/continuous/hold: Continuous

5.2.2 INPUT POWER

The computer display system requires single phase 109 to 121 volts, AC 59 to 61 hertz. The total requirement of 12 amperes is divided as follows:

A. Instrument power – 10 amperes
B. Blower power – 2 amperes

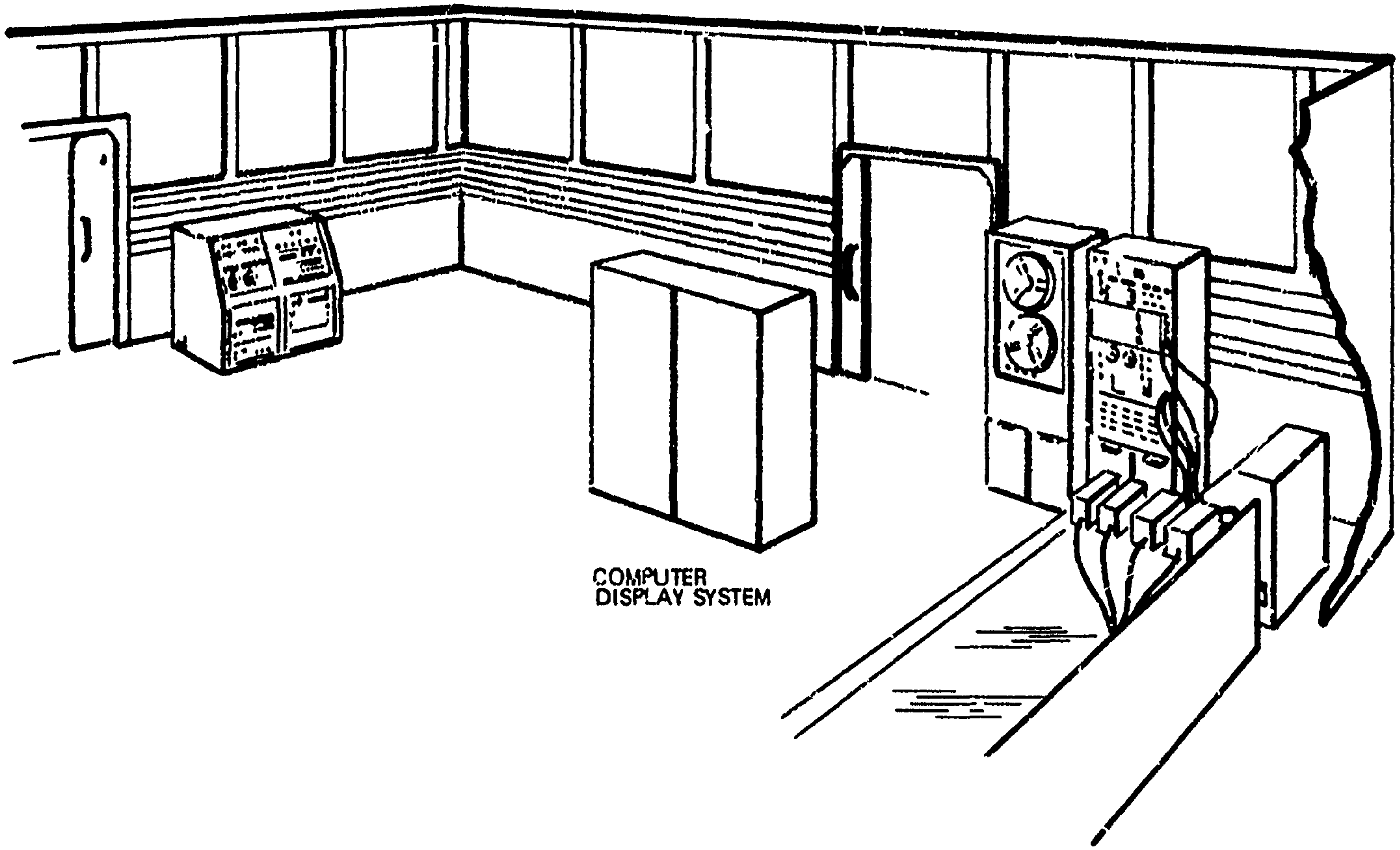


FIGURE 1 TEST CONFIGERATION VIEW

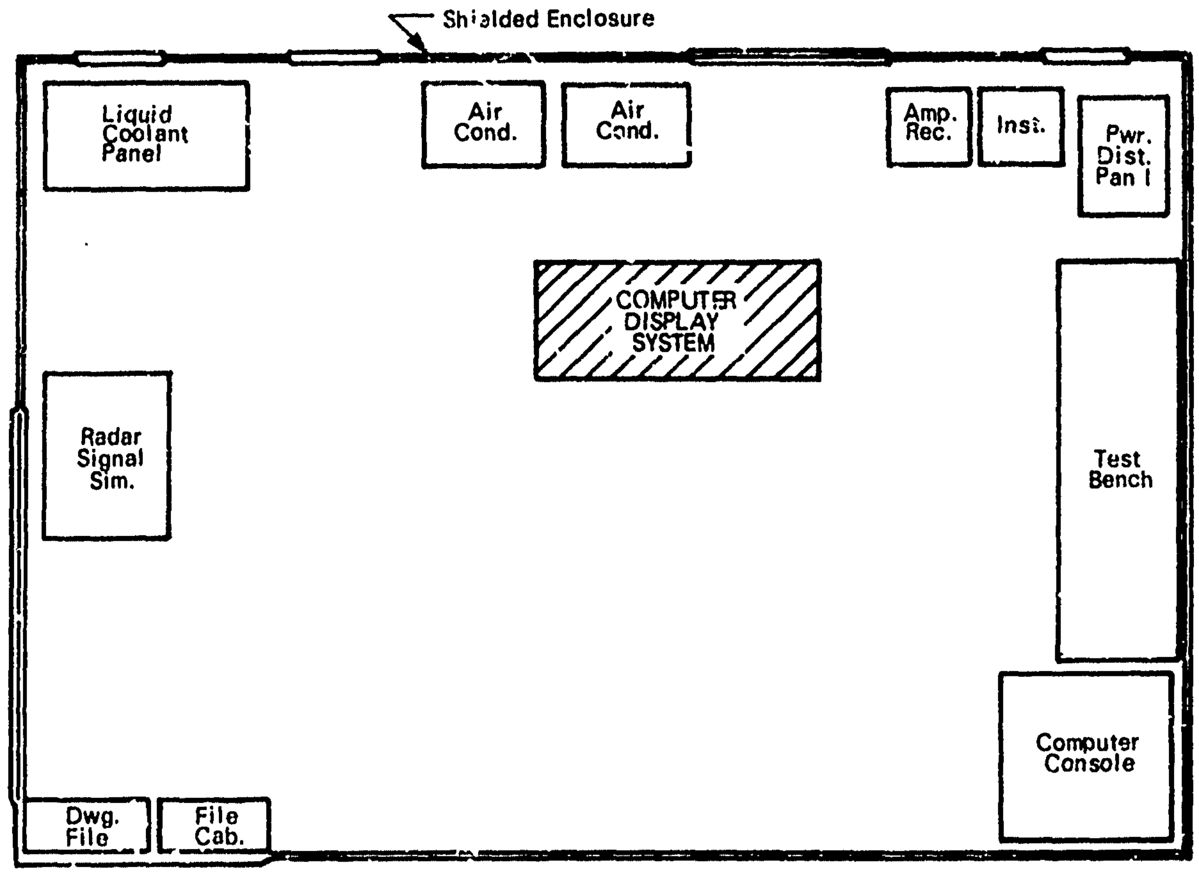


FIGURE 2 TEST CONFIGURATION PLAN

COMPUTER DISPLAY SYSTEM
EQUIPMENT ARRANGEMENT

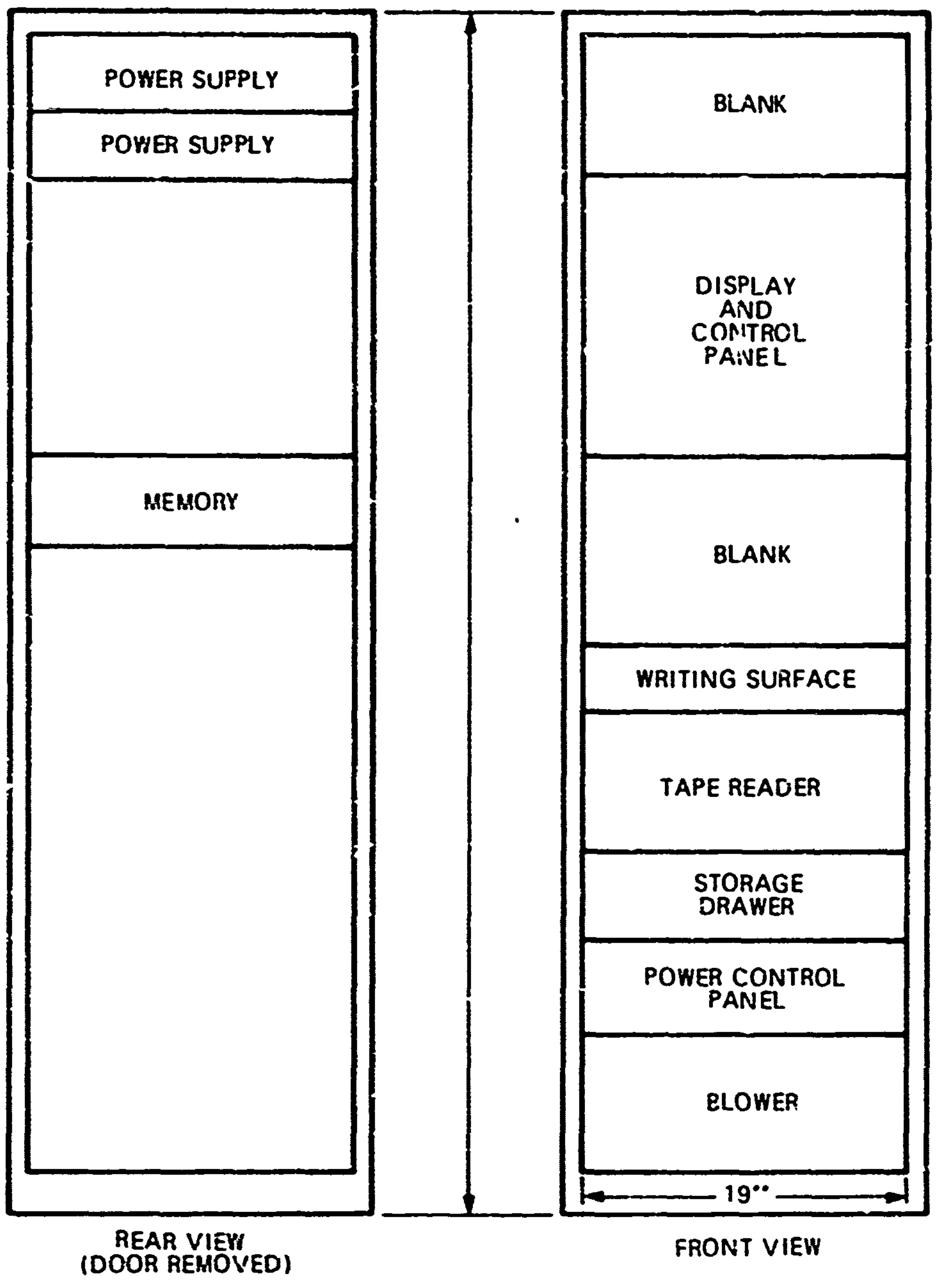


FIGURE 3 EQUIPMENT ARRANGEMENT

5.2.3 INPUT SIGNALS

5.2.3.1 General

The computer display system will be tested in its normal operating condition. A PCM simulator and a data pulse generator will be connected to the CDS as shown in Figure 3A.

5.2.3.2 Control Settings

The PCM simulator controls shall be set as follows: Switch Nos. 1, 5, 6, 7, and 15 down; all others, up. (See Figure 4.) The data pulse generator controls shall be set to obtain a transfer pulse as shown in Figure 5.

5.3 PERFORMANCE CHECKS

Operating characteristics of the CDS will be monitored by the panel readout display. Each front panel control will be switched through its maximum excursion to determine whether any single event transients are produced.

6.0 TEST PROCEDURE

6.1 GENERAL

A. The substitution technique will be used to determine the level of interference. A calibrated impulse generator will be used for broadband measurements, and calibrated signal generators will be used for narrowband measurements

B. The test data sheet, Figure 6, will be used to record the raw data. The test frequency column shows the frequency at which the measurement was made. The meter indication and the attenuator setting columns give the raw data. A four-part column, conversion factors, is used for current probe, bandwidth, cable losses, and antenna factor. Finalized data belongs in the final data column. The entries in this column can be compared with the entries in the specification limit column Any pertinent remarks can be recorded in the last column.

C. Test frequencies will not be selected before the interference test. The interference measuring instrument will be slowly scanned and the frequencies at which the maximum interference is obtained will be selected as the broadband test frequencies. At least one broadband test frequency will be measured per octave. All narrowband signals shall be recorded.

D. For broadband signals, the interference measuring device function switch will be in its peak position; for narrowband signals the switch will be in the field intensity (CW) position.

E. During all measurements, a loudspeaker will monitor the audio output of the interference measuring device.

F. At each frequency where interference is measured, the ambient interference level will be measured with the computer display system in a power-off condition.

G. Each set of measured data will be presented in graphical form. The specification limits and ambient levels will also be plotted.

H. Photographs of each test will be included in the test report.

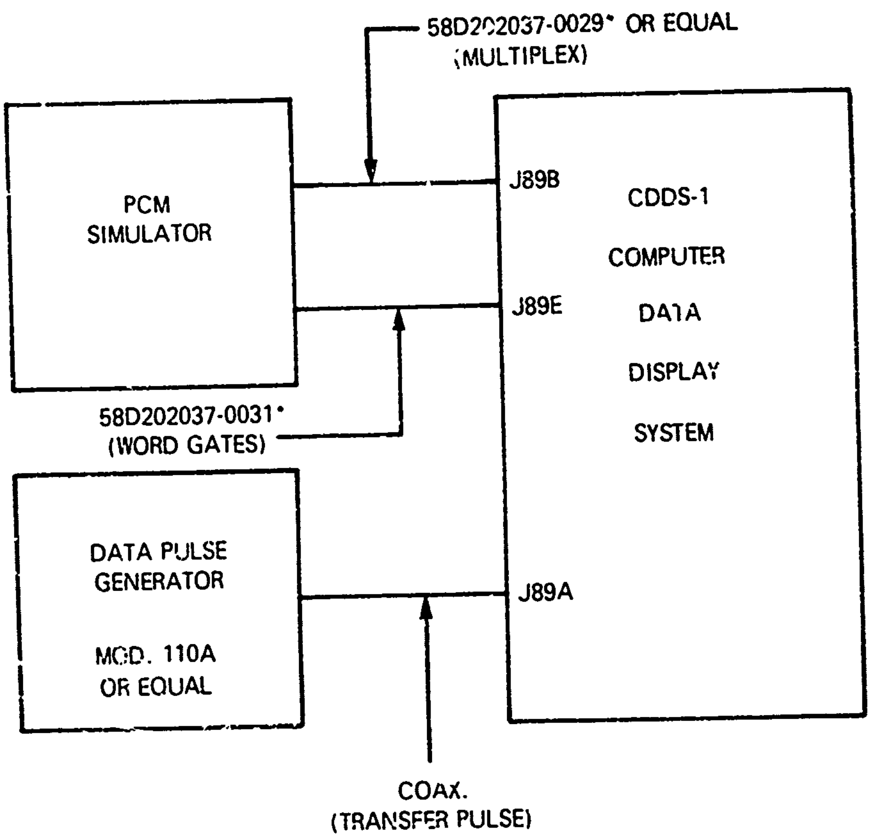
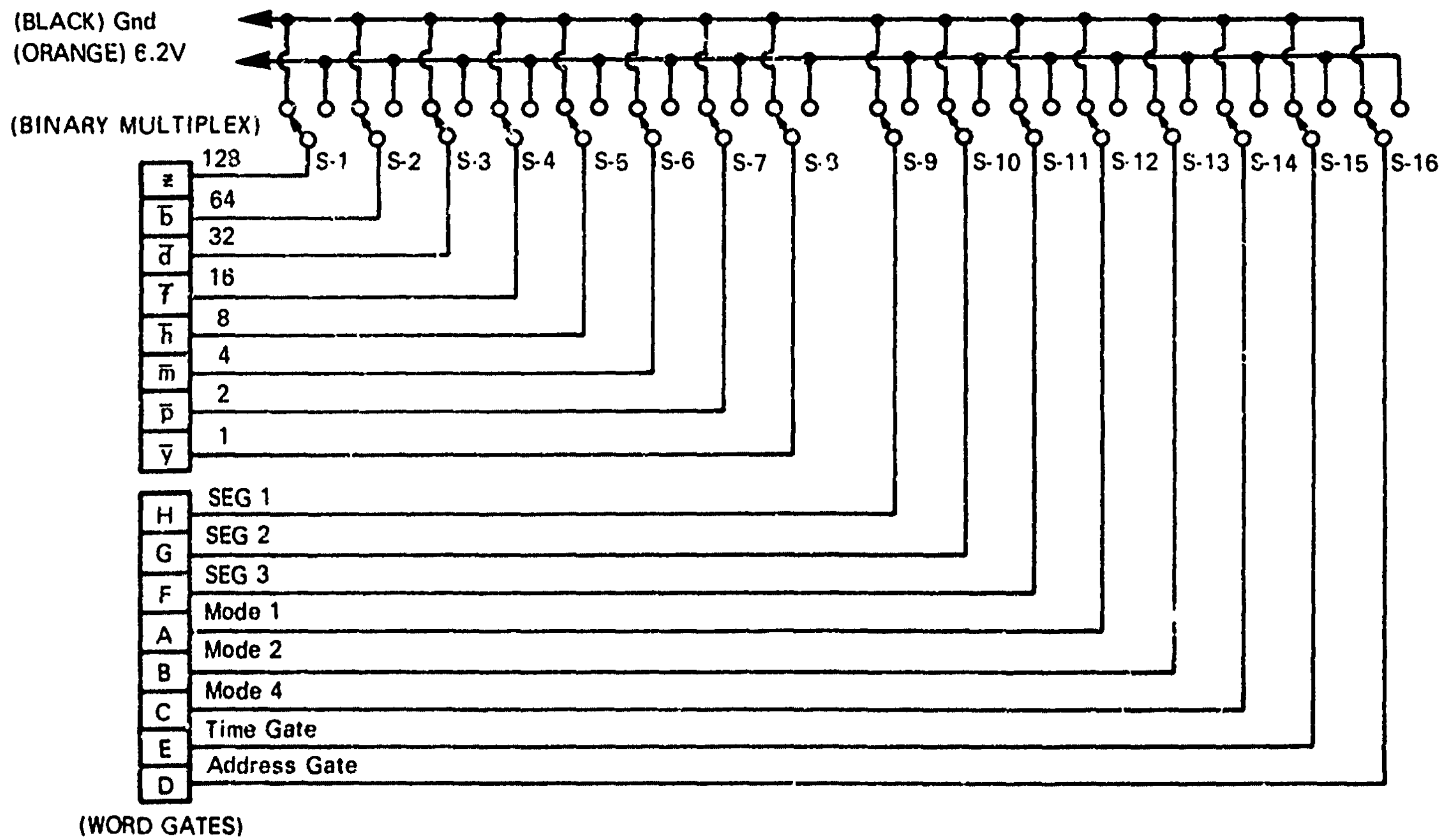


FIGURE 3A SIMULATED OPERATION BLOCK DIAGRAM



NOTE: All switches shown in the Down "O" position

FIGURE 4 PCM SIMULATOR

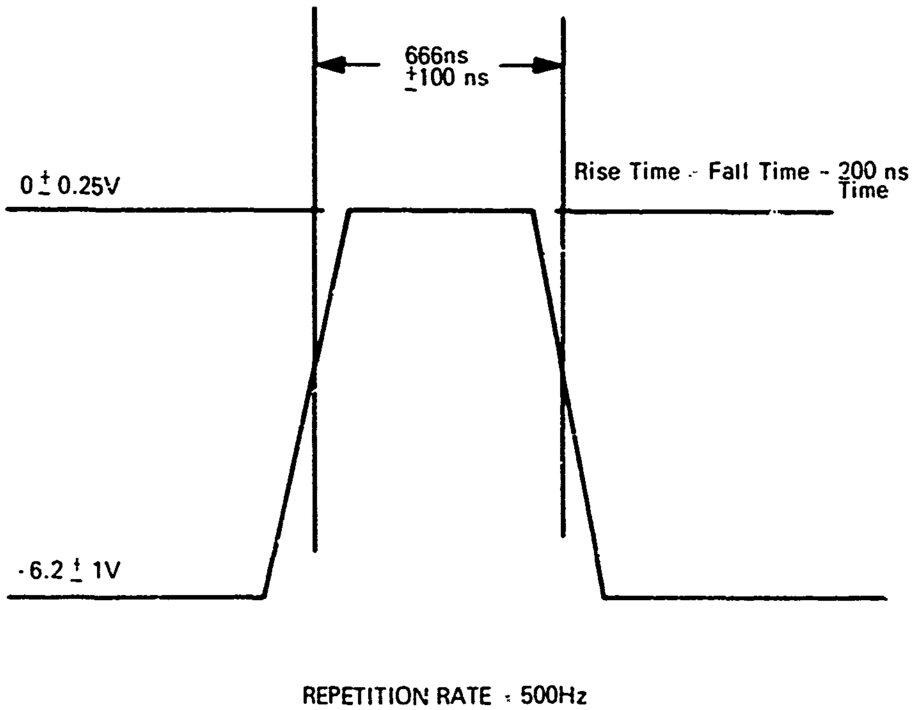


FIGURE 5 TRANSFER PULSE CHARACTERISTICS

TECHNICIAN: W. N. Bridges	DATE: January 26, 19XX
SERIAL NO: 1003	EQUIP. NOMENCLATURE: Longhorn Model 7511
TEST METHOD: CE 03	TYPE OF MEAS: ☐ RADIATED ☐ NB
MEASUREMENT POINT: P.L. φ A	☒ CONDUCTED ☒ BB
TEST FREQ. RANGE: 20 k-50 MHz	MEAS. TECHNIQUE: ☒ CAL. VOLTMETER
MODE OF OPERATION: NORMAL MODE	☐ SLIDEBACK ☐ SUBSTITUTION

IDENT. OF TEST INSTRUMENTATION (SEE TEST INSTRUMENTATION LIST FOR CODE)
2 3 10 17

TEST FREQ kHz	METER READING dB/μV	ATTEN. SETTING dB	CONVERSION FACTORS* Ⓐ	Ⓑ	Ⓒ	Ⓓ	FINAL DATA dB/μa/MHz	SPEC LIMIT dB/μa/MHz	REMARKS
20.0	18.0	40	+5.0	42.0	0		105.0	124.0	
27.5	19.5	40	+4.0	42.0	0		105.5	120.0	
34.2	17.0	40	+2.5	41.5	0		101.0	115.0	
43.0	4.0	40	+2.0	41.0	0		97.0	112.0	

*CODE Ⓐ CURRENT PROBE Ⓑ BANDWIDTH Ⓒ CABLE LOSS Ⓓ

FIGURE 6 TEST DATA SHEET

6.2 CONDUCTED EMISSION

6.2.1 AC POWER LINES (CE01, CE03)

A. Test configuration is shown in Figure 7.

B. Limits – EMI in the frequency range of 30 Hz to 50 MHz appearing on the power leads of the computer shall not exceed the values shown in Figures 8, 9, 10, and 11.

C. Test Procedure: At each frequency measured, the clamp-on current probe shall be positioned to obtain maximum interference level. Record these positions. Scan the 30-Hz to 50-MHz range for broadband emissions. At each detected signal, switch the meter detector function to average to find out if interference is narrowband. Perform a second scan at the potential narrowband frequencies. Record detected levels on a test data sheet (see Figure 6). Measurements will be made separately on each power lead.

6.2.2 CONTROL AND SIGNAL LEADS (CE02, CE04)

A. Test configuration is shown in Figure 12.

B. Limits – Electromagnetic emission in the frequency range of 30 Hz to 50 MHz appearing on the digital display control leads shall not exceed the values shown in Figures 8, 9, 10, and 11.

C. Test Procedure: The control and signal leads shall be divided into four groups as follows:

(1) Control lead supply
(2) Control lead return
(3) Signal lead supply
(4) Signal lead return

Measurements on each of the four groups will be made with a clamp-on current probe. Position each probe on the cable to measure maximum interference. Record the position of the probe. Each current probe will be connected to a coaxial selector switch which, in turn, will be connected to the input of the interference measurement set.

If a group of leads is found to exceed the specified limits, these leads shall be identified and measured individually. The specified limit applies to each individual lead.

The test frequency spectrum shall be scanned for broadband emissions. At each detected signal, the detector function shall be switched to average to find out if the signal is narrowband. A second scan shall be performed at the potential narrowband frequencies. Detected levels of both broadband and narrowband emissions shall be recorded on the test data sheet (see Figure 6).

6.3 RADIATED EMISSION

6.3.1 MAGNETIC FIELD

A. Test configuration is shown in Figure 13; the signal source, however, is not used.

B. Limits – Magnetic field emission in the frequency range of 30 Hz to 30 kHz shall not exceed the values shown in Figure 14.

1. 5 cm Standoffs
2. Low Impedance Bond to Ground Plane
3. Current Probe
4. Test Sample Chassis Ground
5. High Side
6. Return
7. DC bond impedance between the ground plane and enclosure shall not exceed 2.5 milliohms.

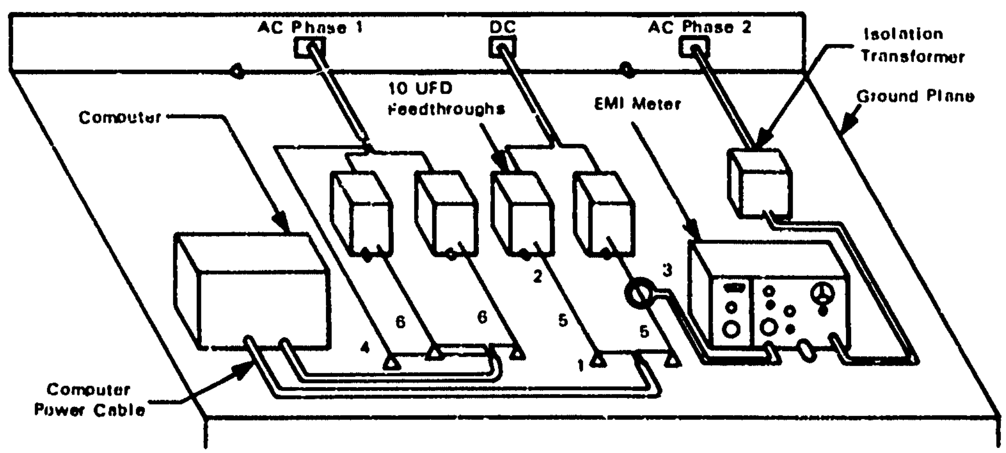


FIGURE 7 CURRENT PROBE TEST SETUP FOR CONDUCTED EMISSION MEASUREMENTS ON POWER LEADS

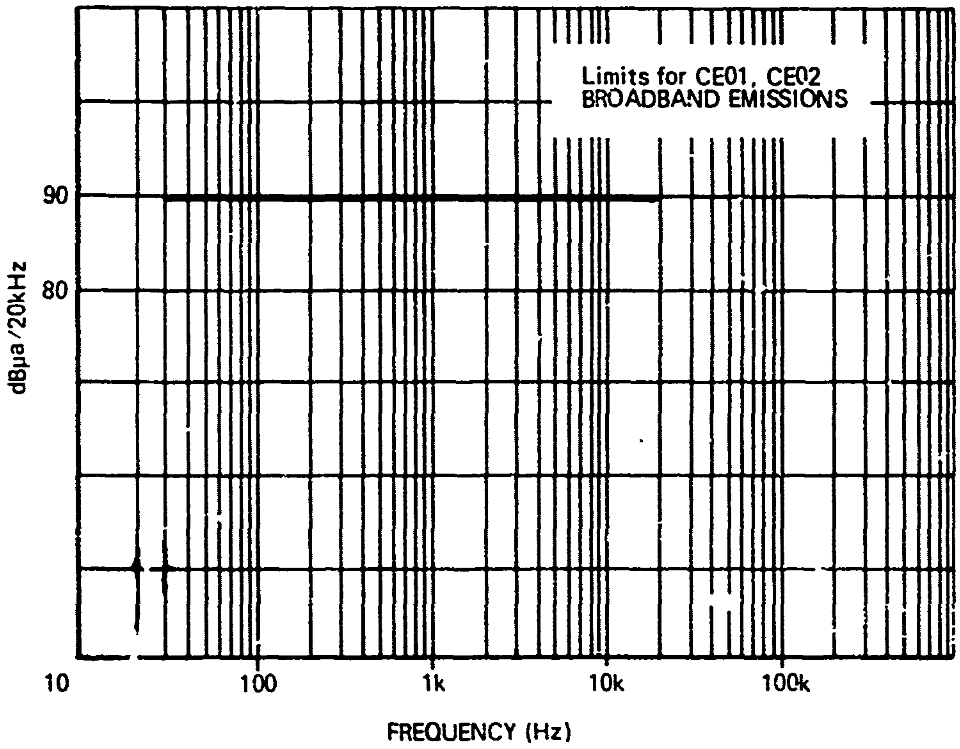


FIGURE 8 CONDUCTED BROADBAND EMISSION

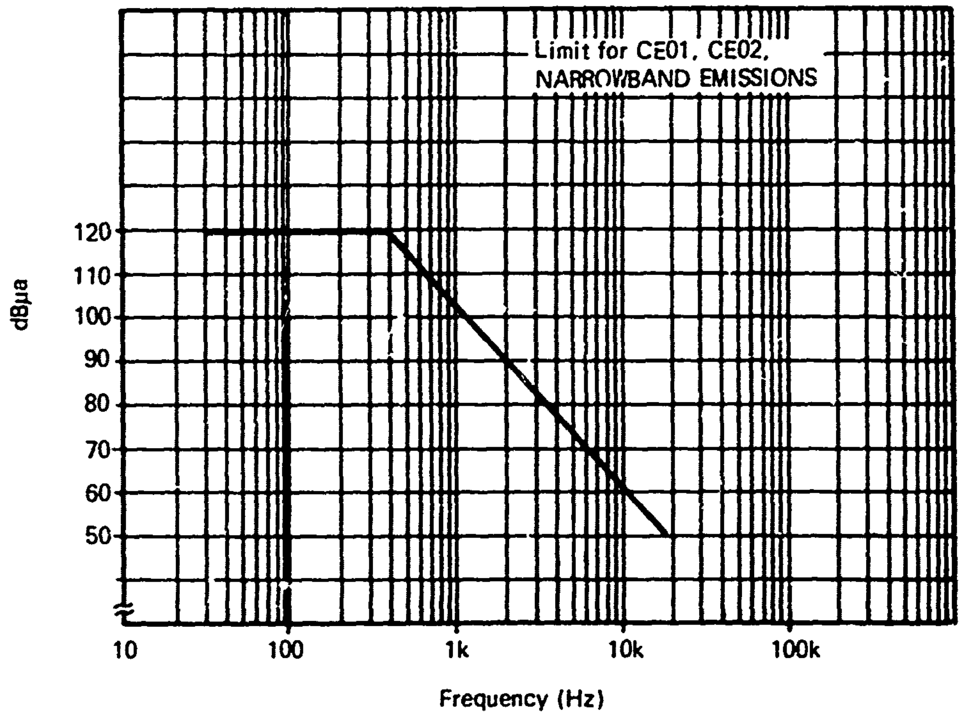


FIGURE 9 CONDUCTED NARROWBAND EMISSIONS

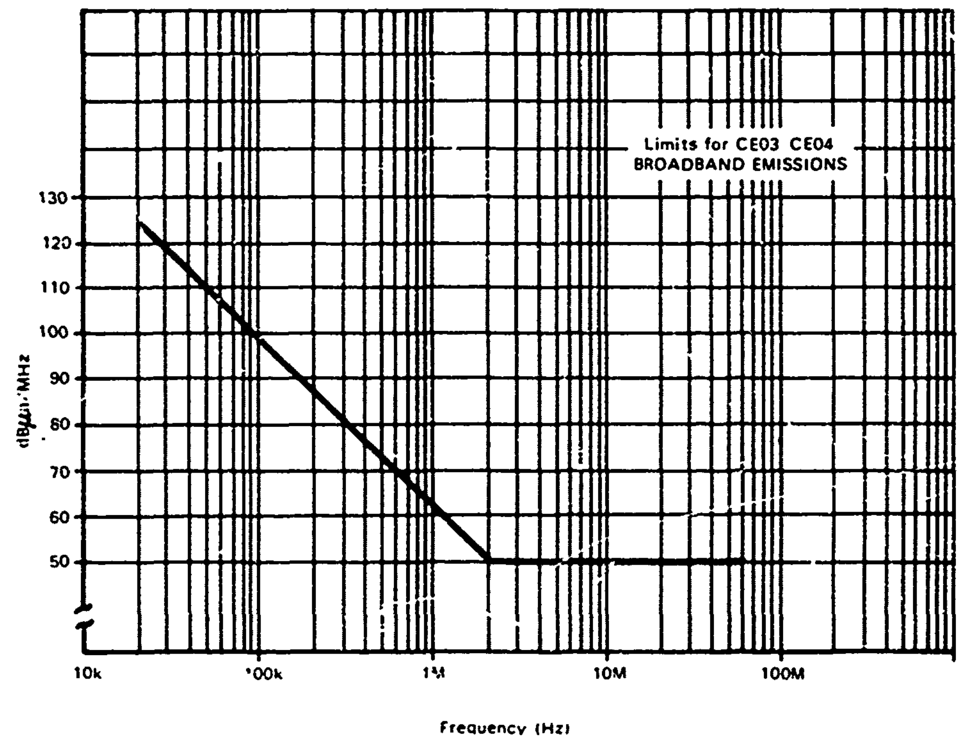


FIGURE 10 CONDUCTED BROADBAND EMISSIONS

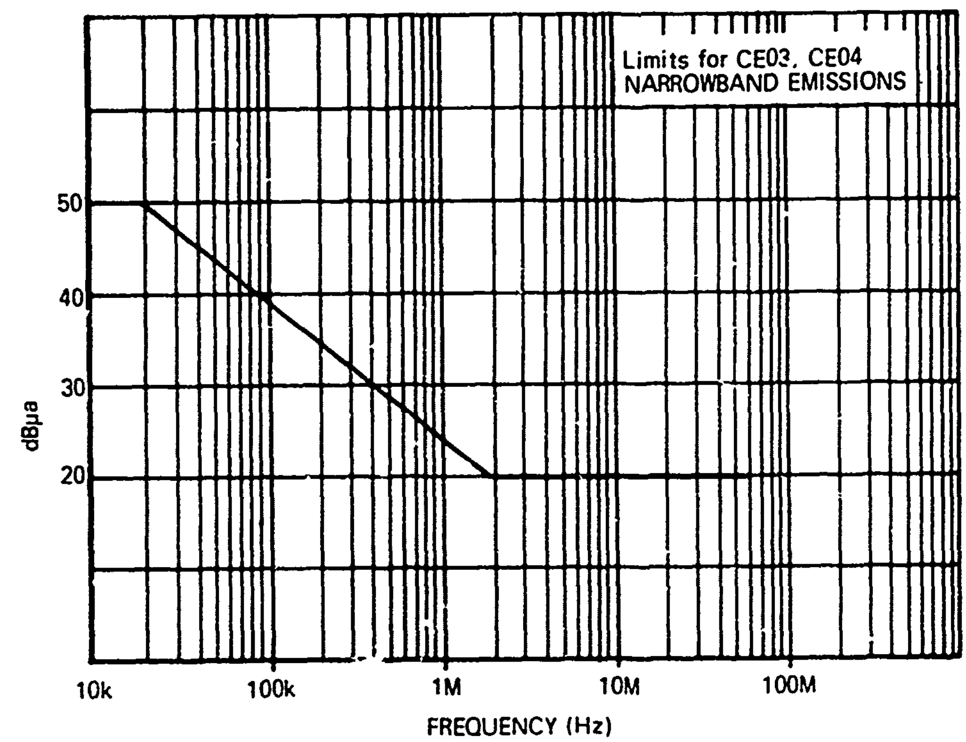


FIGURE 11 CONDUCTED NARROWBAND EMISSIONS

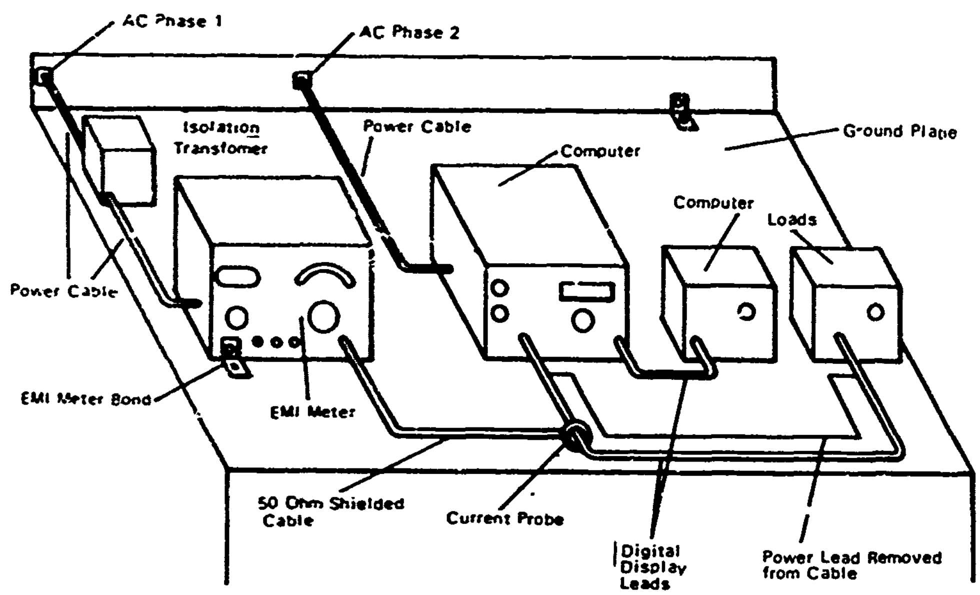
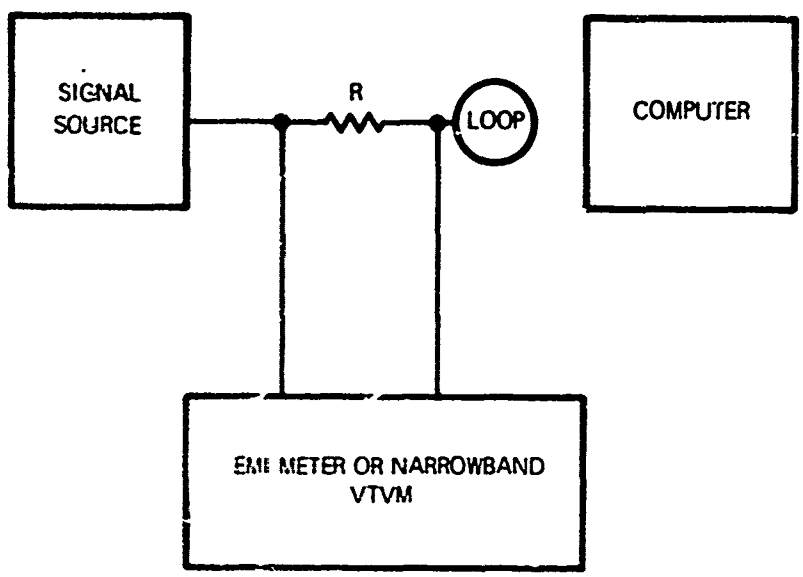


FIGURE 12 CURRENT PROBE TEST SETUP FOR CONDUCTED MEASUREMENT OF INTERCONNECTING CABLES.



R = Resistor of 1 ohm (A 1-volt output to the voltmeter yields a 1 amp input to the loop)

FIGURE 13 RADIATED EMISSION AND SUSCEPTIBILITY 30 Hz TO 30 kHz, MAGNETIC FIELD

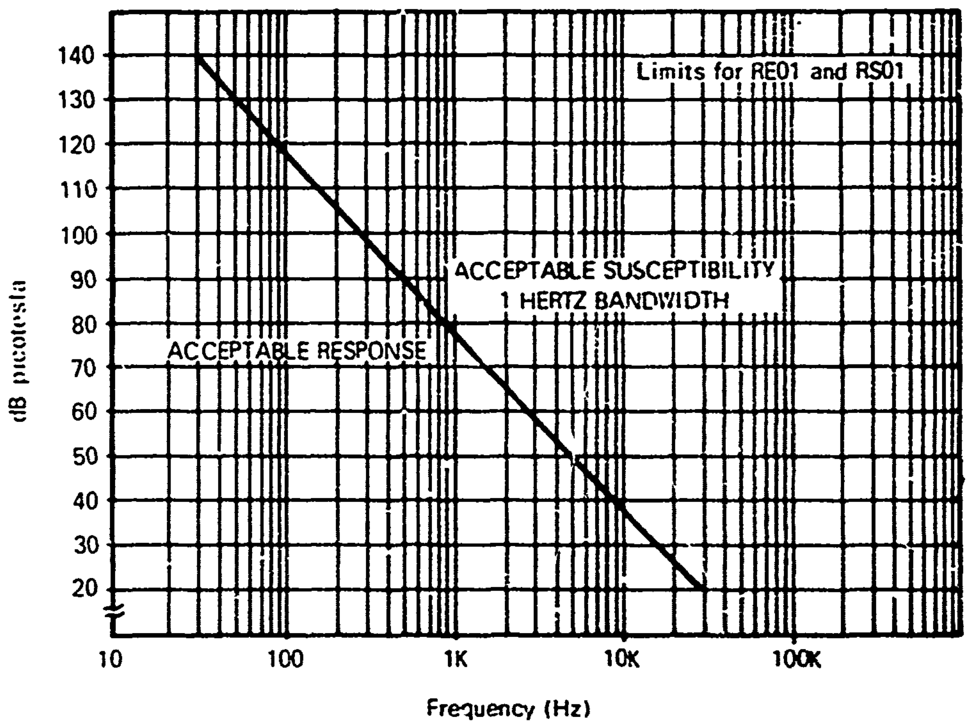


FIGURE 14. RADIATED EMISSION AND SUSCEPTIBILITY (MAGNETIC)

C. Test procedure –

(1) Position the loop sensor approximately 7 cm from one face of the computer, with the plane of the loop parallel to the face of the computer. The loop shall be located near the control connector.

(2) Scan the EMI meter across the test frequency range to locate the frequencies of maximum radiation, including the frequencies intentionally existing within the computer. Record these frequencies on the data sheet (Figure 6).

(3) Retune the EMI meter to one of the frequencies located in (2) above and position the loop sensor 7 cm from the surface of the computer with the plane of the loop parallel to the surface.

(4) Monitor the output of the EMI meter while moving the loop sensor over the entire face of the computer. Note the point of maximum radiation.

(5) At the point of maximum radiation, orient the plane of the loop sensor to give a maximum reading on the meter and record this measurement.

(6) Repeat steps (3) through (5) for at least 2 frequencies of maximum radiation/octave below 200 Hz and for 3 frequencies of maximum radiation/octave above 200 Hz.

(7) Repeat steps (1) through (6) for each face of the computer.

6.3.2 RADIATED EMISSION, ELECTRIC FIELD (RE02)

A. Test configuration – The basic test setup is shown in Figure 15 showing the 41-inch rod antenna used in the frequency range of 14 kHz to 25 MHz. Refer to C below for test antenna to be used above 25 MHz.

B. Limits –

(1) Narrowband E-field emission in the frequency range of 14 kHz to 40 MHz shall not be generated and radiated in excess of the value shown in Figure 16. This test is limited to 40 MHz, which is ten times the highest computer internal frequency of 4 MHz.

(2) Broadband E-field emission in the frequency range of 150 kHz to 1 GHz shall not be generated or radiated in excess of the values shown in Figure 17. In the frequency range of 25 to 200 MHz, the specified limit shall be met for both horizontally and vertically polarized waves.

C. Test Antennas:

Test Antennas	Characteristics	Frequency Range
41-inch rod	Effective antenna height 0.5 meters. Appropriate matching network. Counterpoise whose sides measure 60 cm.	14 kHz – 25 MHz

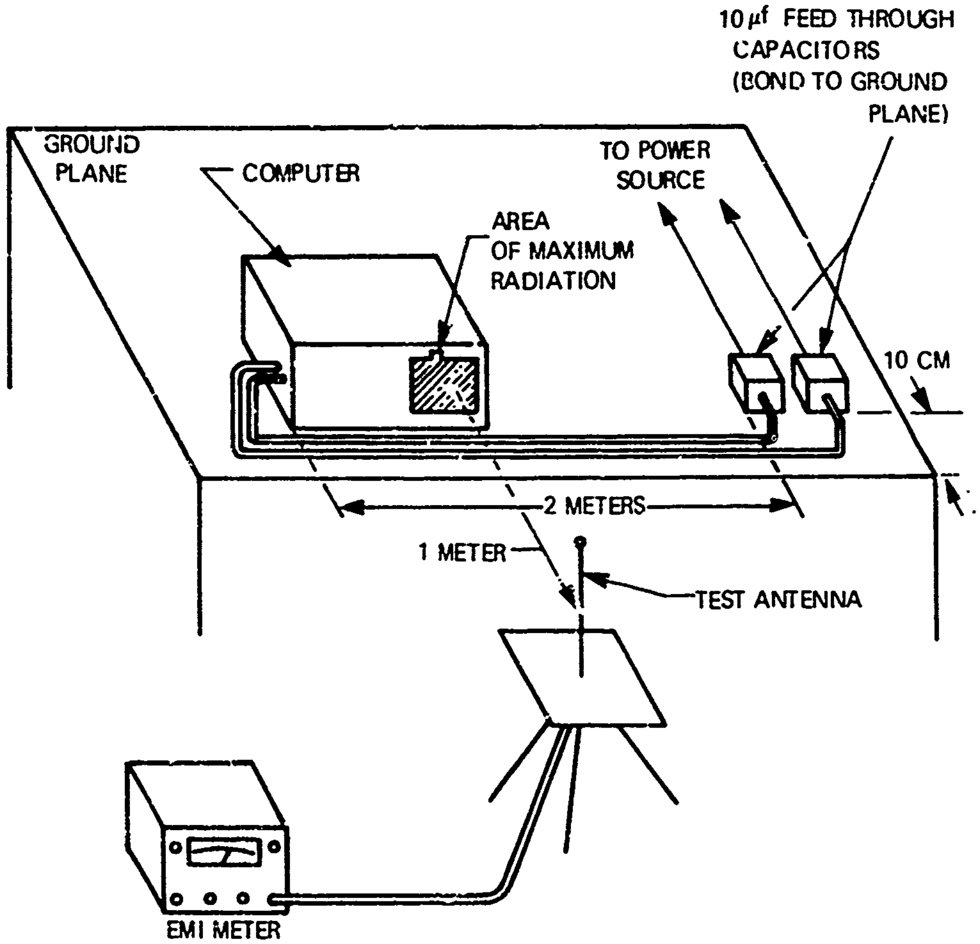


FIGURE 15 TEST SETUP FOR RADIATED MEASUREMENTS

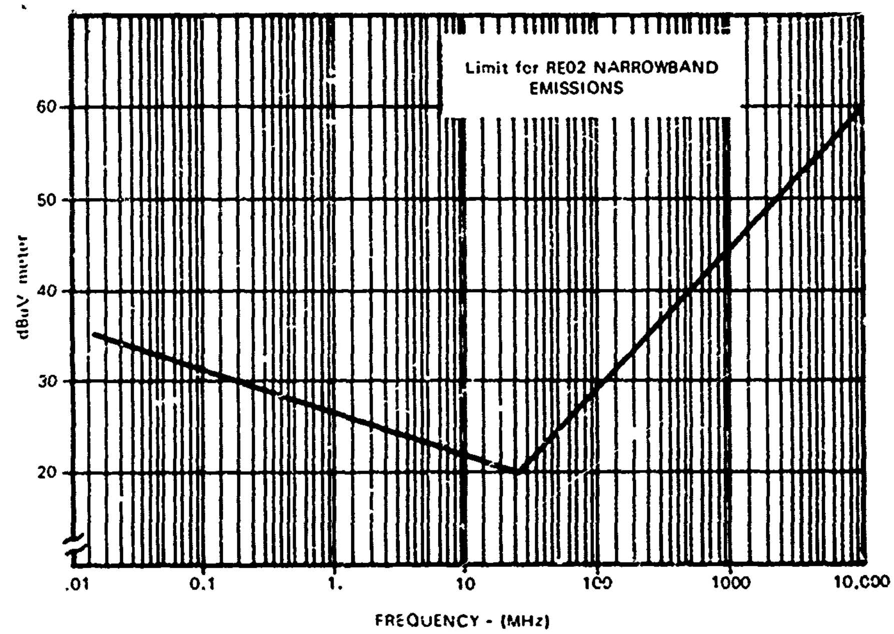


FIGURE 16 NARROWBAND RADIATED EMISSION LIMITS

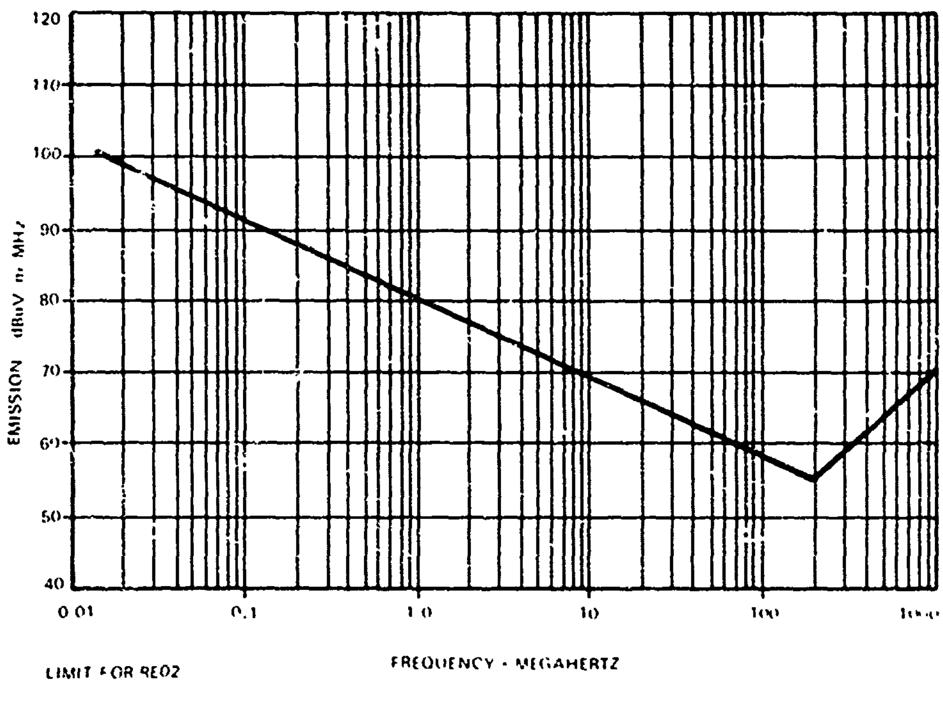


FIGURE 17 RADIATED BROADBAND EMISSION LIMIT

Bioconical	Constructed in accordance with Smith Document ANT S-5A. Maximum antenna factor is shown in Figure 18. Measurement procedures for determining antenna factors are stated in MIL-STD-461 paragraph 5.2.7.	25 MHz – 200 MHz
Conical Logarithmic Spiral	Constructed in accordance with Smith drawing 711168-J. Antenna factors are shown in Figure 19.	200 MHz – 1 GHz
Conical Logarithmic Spiral	Constructed in accordance with Smith drawing 711169-J. The maximum values of antenna factors are shown in Figure 20.	1 – 10 GHz

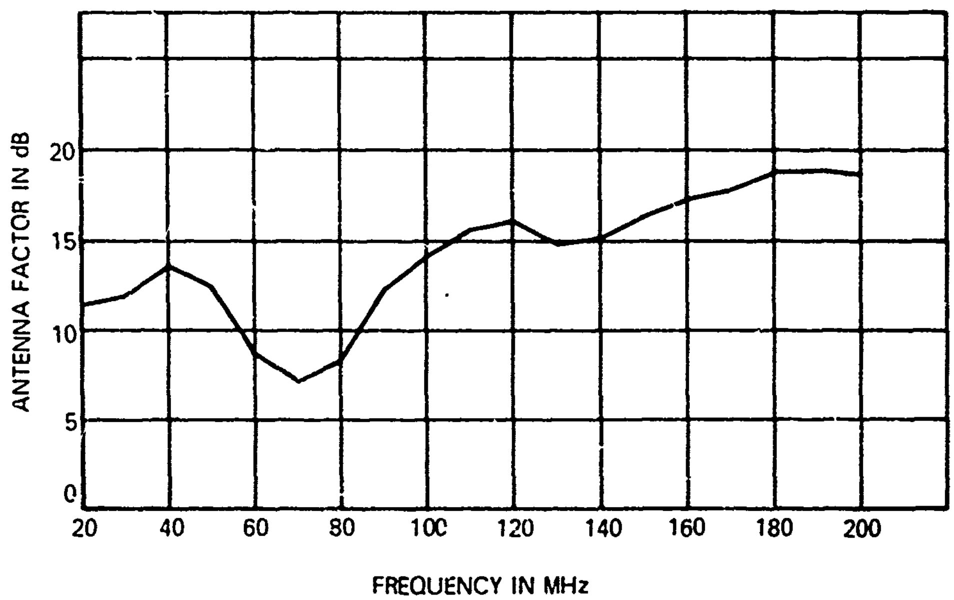
D. Test Procedure

(1) Probe the computer as indicated below to locate the points of maximum radiation from the computer:

(a) Placement and Selection of Measuring Antennas - Each face of the test sample shall be probed with a loop to determine the areas producing maximum emission. These areas shall be located 1 meter from the applicable test antenna specified in C above. Probing and frequency scanning shall be performed over the frequency range of each of the specified antennas to determine the worst case condition. The probe shall be oriented for maximum pickup approximately 5 cm from the surface of the test sample.

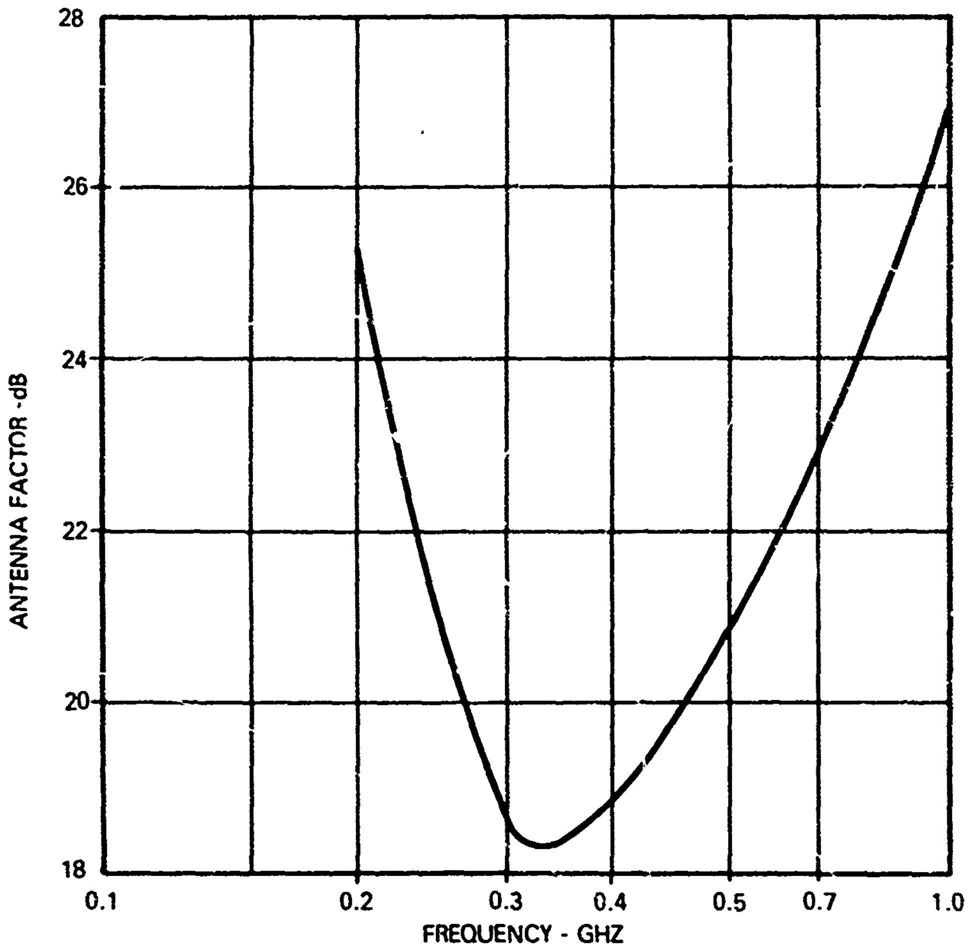
When radiated emission measurements are made, no point of the measuring antenna shall be less than 1 meter from the walls of the shielded enclosure or obstruction. Figure 21 shows a general antenna placement setup for emission measurements.

For radiated emission measurements between 25 and 200 MHz, the bioconical antenna shall be positioned alternately to measure the vertical and horizontal components of the emission. (For radiated susceptibility measurements, between 20 and 200 MHz, the bioconical antenna shall be positioned to generate alternately vertical and horizontal fields.)



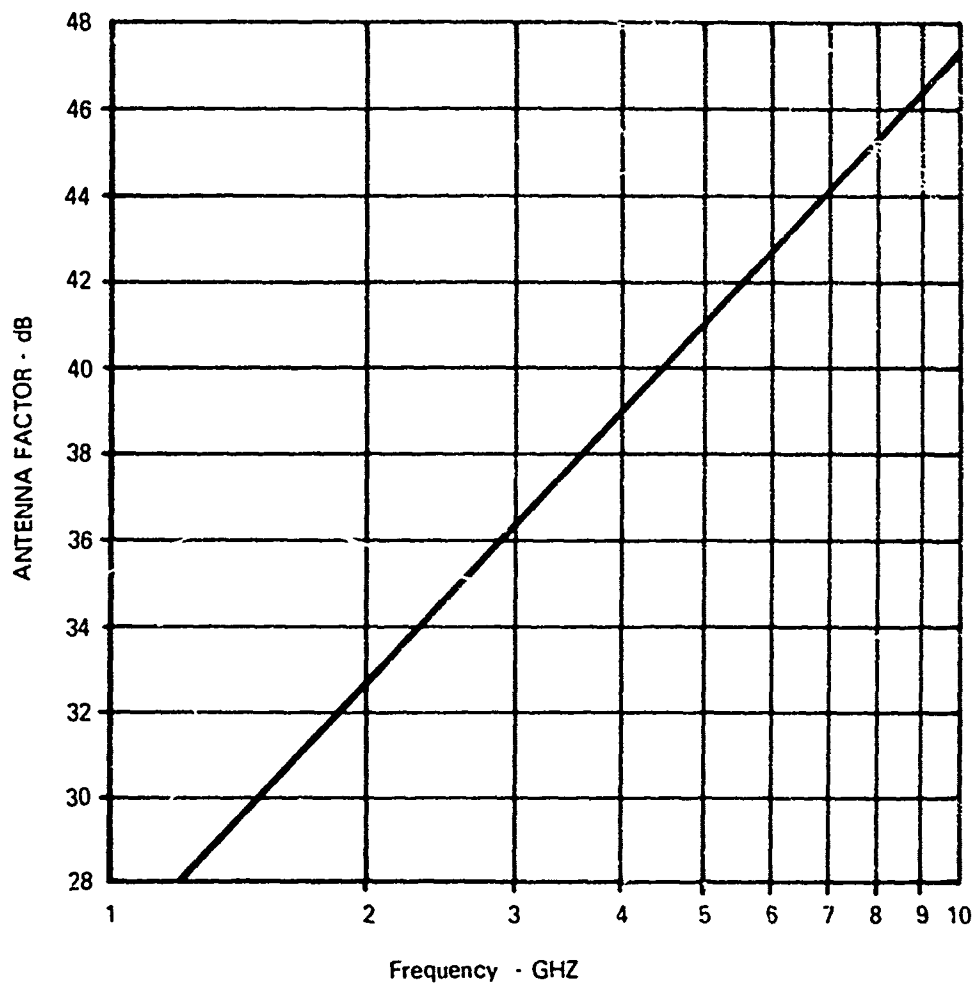
NOTE: Add antenna factor (dB) to receiver reading (dbμV) to convert to field intensity (dBμV/meter)

FIGURE 18 ANTENNA FACTOR FOR BICONICAL ANTENNA



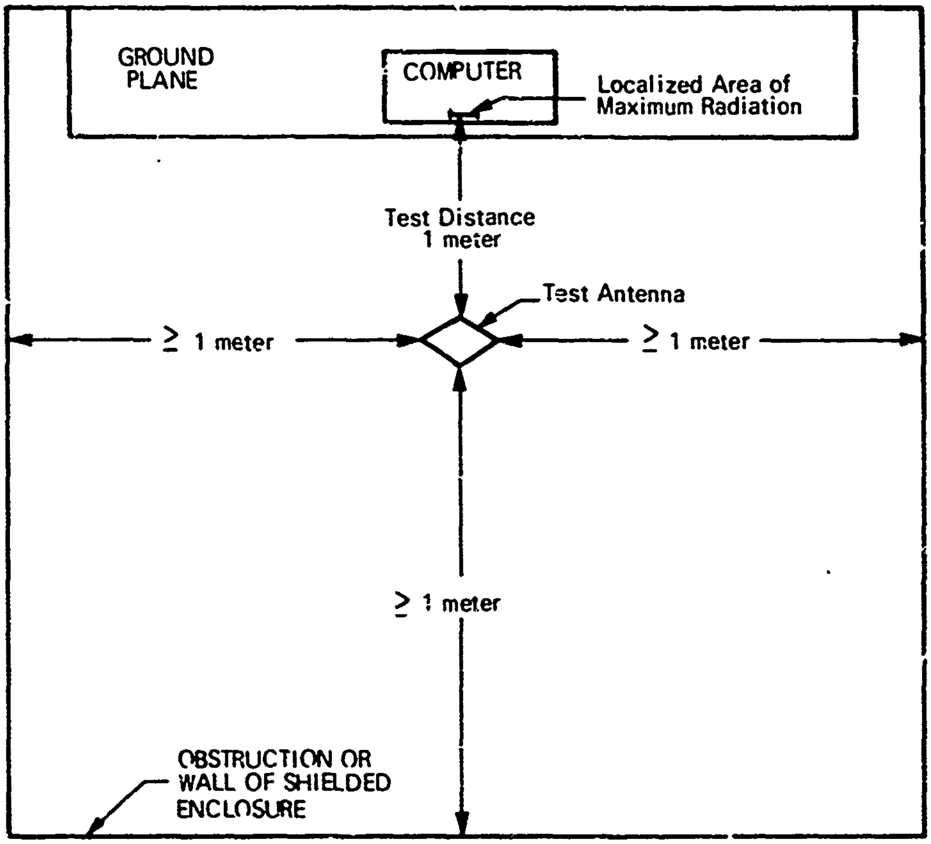
NOTE - Add antenna factor (dB) to receiver reading (dBuV) to convert to field intensity (dBuV/meter)

FIGURE 19 ANTENNA FACTOR FOR LOG SPIRAL ANTENNA, 0.1 TO 1.0 GHZ



NOTE - Add antenna factor (dB) to receiver reading (dbμV) to convert to field intensity (dBμV/meter)

FIGURE 20 ANTENNA FACTOR FOR LOG SPIRAL ANTENNA 1 TO 10 GHZ



NOTES:
(1) Height of shielded enclosure (if used) ≥ 2.5 meter
(2) End of rod antenna shall not be closer than 30 cm to ceiling of shielded enclosure.
(3) Ends of biconical antenna shall not be closer than 30 cm to ceiling and floor of shielded enclosure when measuring vertical polarizations.

FIGURE 21 PLACEMENT OF ANTENNAS FOR RADIATED EMISSION MEASUREMENTS

(b) Measuring Frequencies – The entire specified frequency range for each applicable test shall be scanned. Measurements shall be taken at not less than three frequencies per octave representing the maximum indications within the octave. In addition, measurements shall also be made at the test sample's critical frequencies (4 MHz and harmonics thereof).

(2) Select the position of the test antenna as required above. In the 25- to 200-MHz range, position the antenna to make both vertical and horizontal polarization measurements.

(3) Scan the applicable frequency range of this test with the EMI meter and take measurements as required for each antenna.

6.3.3 MAGNETIC FIELD, 20 Hz to 50 kHz (T) RE04

A. The instrumentation will be connected as shown in the block diagram, Figure 22. The test setup will be arranged as shown in Figure 23.

B. Limits – Magnetic field emission in the frequency range of 20 Hz to 50 kHz shall not exceed the values shown in Figure 24.

C. Test Procedure –

(1) Probe each face of the cabinet and the signal and control cable to determine the localized areas producing maximum emission. Probing and frequency scanning shall be performed over the frequency range of 20 Hz to 50 kHz at the point or points of maximum emission (the maximum pickup at a distance of one meter from the area of emission).

(2) Record data at maximums (no fewer than 3 frequencies per octave) in units of magnetic field strength expressed in amperes per meter. Calibrate with known magnetic field at each measurement frequency.

6.4 <u>CONDUCTED SUSCEPTIBILITY</u>

6.4.1 POWER LEADS, 30 Hz to 50 kHz (CS01)

A. Test configuration – The test setup is shown in Figure 25.

B. Limits – No susceptible condition shall exist when the computer has an interference signal superimposed on the power leads in the frequency range of 30 Hz to 50 kHz. The injected signal levels are shown in Figure 26.

C. Test Procedure –

(1) The output impedance on the signal source looking into the secondary terminals of the isolation transformer is unknown. Measurements shall be made as follows:

(a) Apply a signal to the primary of the transformer and measure the open circuit voltage (Voc).

(b) Connect a known load, R_2 across the secondary and measure the closed circuit secondary voltage (Vcc).

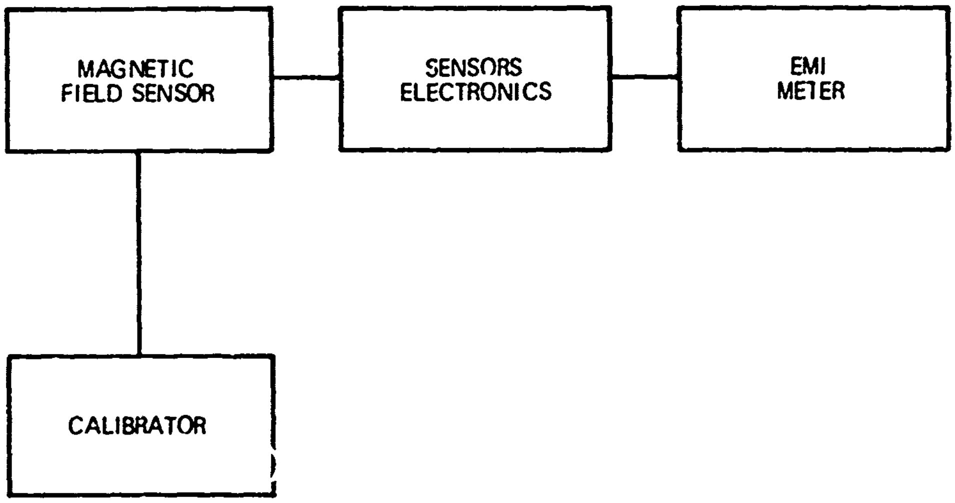


FIGURE 22 INSTRUMENTATION BLOCK DIAGRAM

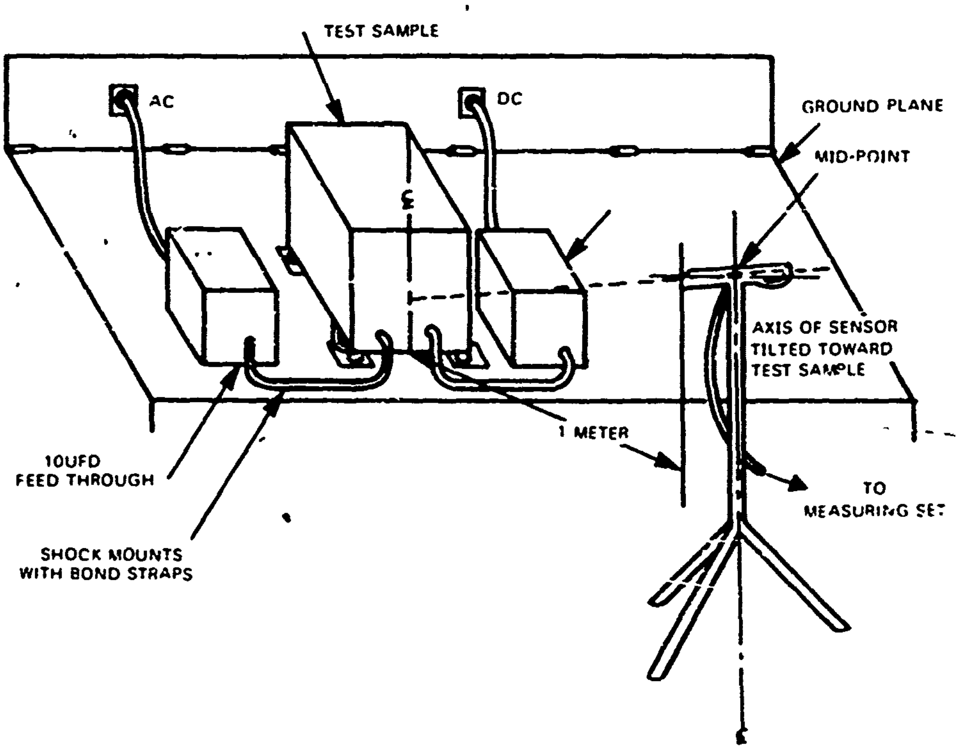


FIGURE 23 TEST SETUP FOR RADIATION MEASUREMENTS (MAGNETIC FIELD SENSOR)

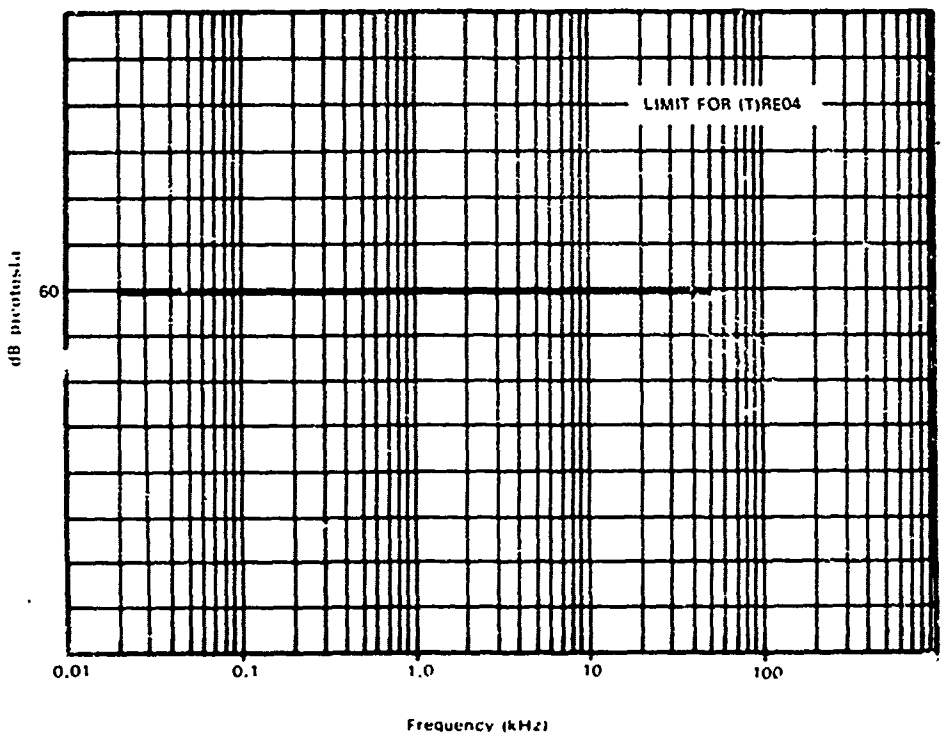


FIGURE 24 RADIATED MAGNETIC FIELD EMISSION LIMIT

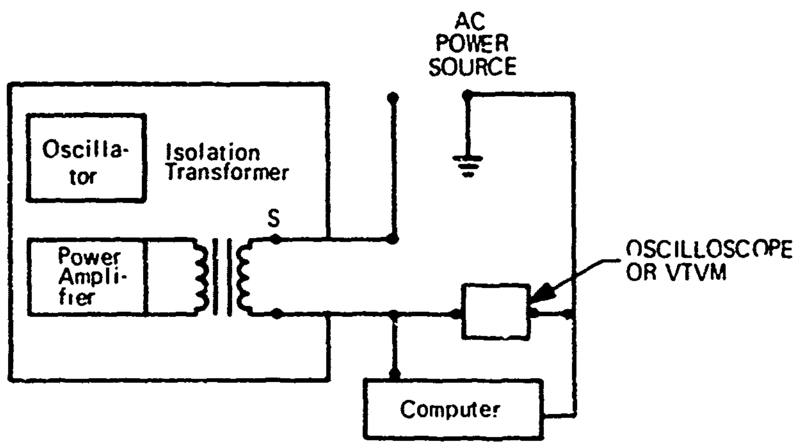
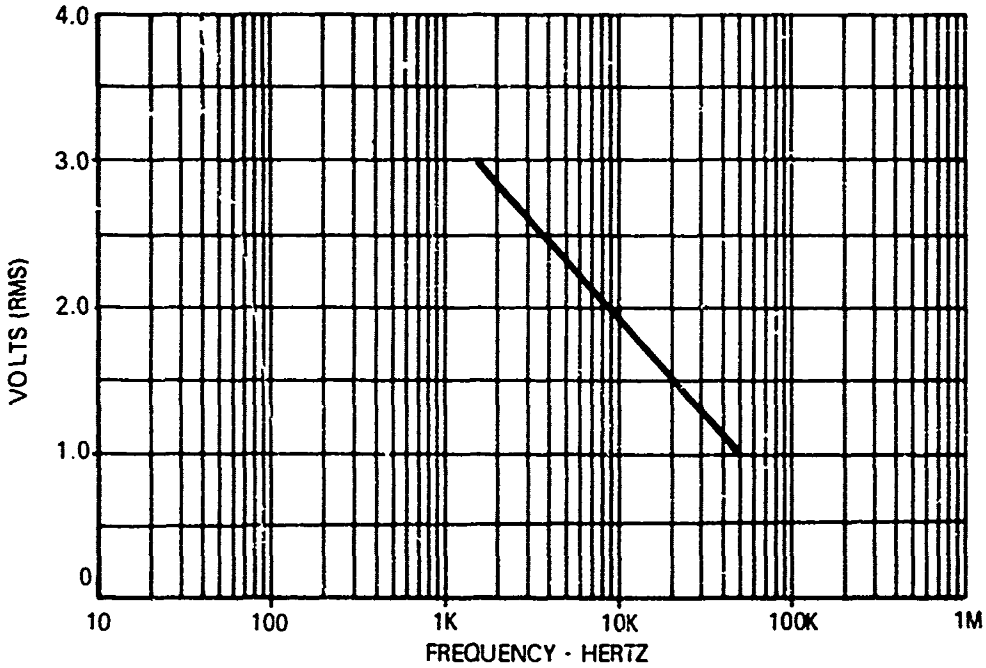


FIGURE 25 CONDUCTED SUSCEPTIBILITY, 30 Hz TO 50 kHz
TYPICAL TEST SETUP



LIMITS FOR CS01

FIGURE 26 CONDUCTED AUDIO AND RF SUSCEPTIBILITY LIMIT

(c) The impedance is calculated as follows:

$$Z = \frac{R_2(Voc - Vcc)}{Vcc}$$

(d) Repeat the above at one frequency per decade from 30 Hz to 50 kHz (including 30 Hz and 50 kHz) and record the results.

(e) The measured impedance must be less than or equal to 0.5 ohm. If it is not, adjust the turns ratio until the desired impedance is obtained.

(2) Connect the computer as shown in Figure 25.
NOTE: A network to eliminate the power frequency at the oscilloscope will be used.

(3) The osciliator shall be tuned through the required frequency range, the output adjusted to the specified level, and verification made that the digital display does not change from the normal operation condition. The frequency range of 54 to 66 Hz will be eliminated.

(4) If susceptibility occurs at the specified level, decrease the output to determine the threshold of susceptibility. Record the output on the test data sheet.

(5) Measure the power voltages applied to the test sample, and record the voltage. It is possible that the supply voltage will have to be raised to compensate for losses in the isolation transformer.

6.4.2 POWER LEADS, 50 kHz to 400 MHz (CS02)

A. Test configuration - The test setup is shown in Figure 27.

B. Frequency Range 50 kHz to 400 MHz.

C. Test Procedures –

(1) Connect the equipment as shown in Figure 27.

(2) Apply 1 volt rms (across 50 ohms) to each power lead in turn.

(3) Measure the voltage across the computer terminals, and record the voltage.

(4) If the computer shows a susceptible condition, reduce the signal source output to determine the threshold of susceptibility. Record this voltage level.

6.4.3 POWER LEADS, SPIKE (CS06)

A. Test configuration is shown in Figure 28.

B. The computer should show no susceptible condition when a transient (Figure 30) is superimposed on its power leads.

C. Spike Generator Characteristics –

(1)	Pulse width	10 μs
(2)	Pulse repetition rate	3 to 10 pps

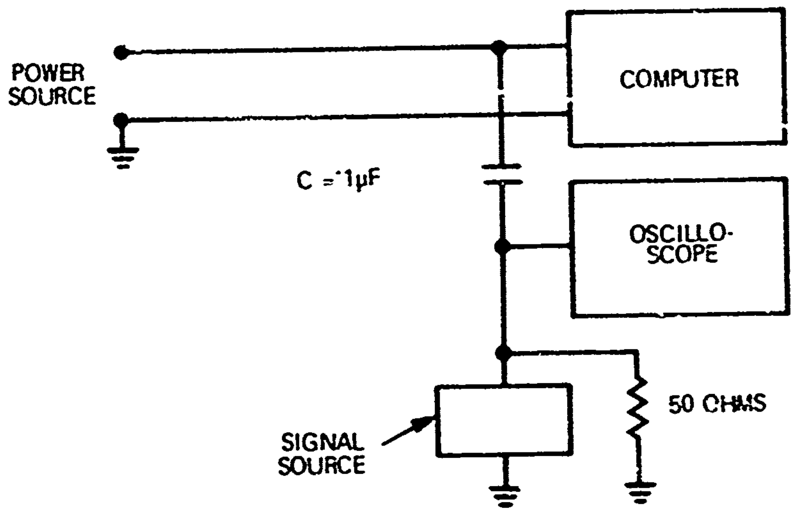


FIGURE 27 CONDUCTED SUSCEPTIBILITY
50 kHz TO 400 MHz

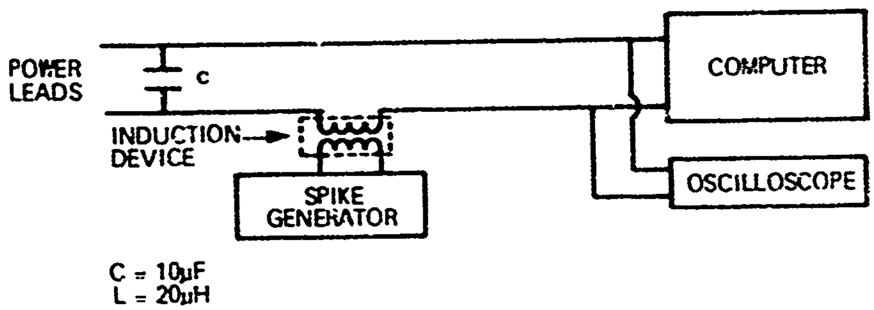


FIGURE 28 CONDUCTED SUSCEPTIBILITY, SPIKE, POWER LEADS;
SERIES INJECTION

(3)	Voltage output	200 volts peak
(4)	Output control	Adjustable from 0 to 200 volts
(5)	Waveshape	Figure C-9
(6)	Output spectrum	160 dB/μV/MHz at 25 kHz decreasing to 115 dB/μV/MHz at 30 MHz
(7)	Phase positioning	0 to 360 degrees
(8)	Source impedance (with injection transformer)	0.06 ohms
(9)	External syn	50 to 800 Hz
(10)	Transformer (current capacity)	30 amperes
(11)	External trigger	0 to 20 pps

D. Test Procedure --

(1) Connect computer and test instrumentation as shown in Figure 28.

(2) The generator (with a high source impedance) output shall be loaded and calibrated as indicated in Figure 29.

(3) The applied spike amplitude, rise time, and duration, as measured by the oscilloscope across the input terminals of the test sample, shall follow the typical waveshape specified in Figure 30.

(4) Synchronization and triggering shall be used to position the spike to specific test sample signal conditions that will produce maximum susceptibility.

(5) Positive and negative, single and repetitive (10 pps) spikes shall be applied to the test sample's ungrounded input lines for no longer than 30 minutes. Spikes shall be synchronized to the power line frequency and positioned on each 90-degree phase position for no less than 5 minutes. Positioning of a spike from 0 to 360 degrees of the power line frequency shall be varied from 50 to 800 Hz and its effect on equipment susceptibility noted. The spike shall be triggered to occur within the time frame of any gate or pulse generated by the logic circuitry.

(6) If susceptibility occurs, determine and record its threshold level, repetition rate, and phase position on the AC waveform.

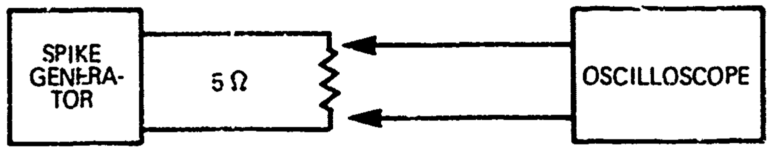
6.5 RADIATED SUSCEPTIBILITY

For susceptibility measurements, no point of the field-generating antennas shall be less than 1 meter from the walls of the enclosure or any obstruction. Figure 31 shows the general antenna placement setup for susceptibility measurements.

6.5.1 MAGNETIC FIELD (RS01)

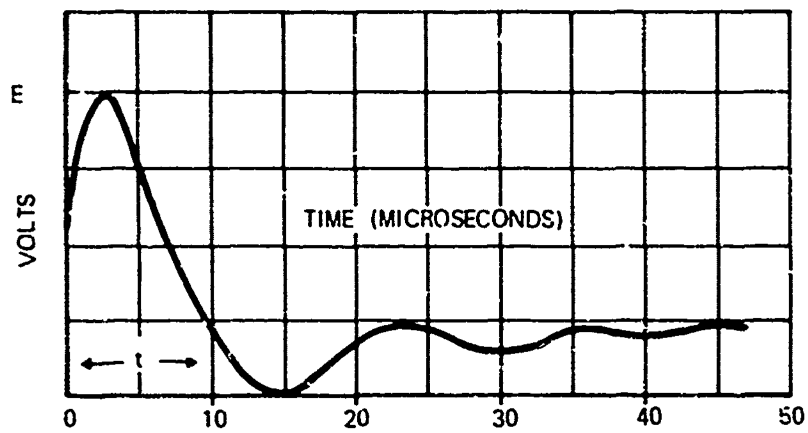
A. Test configuration is shown in Figure 13.

B. Limit -- The magnitude of the magnetic field in the frequency range of 30 Hz to 30 kHz is shown in Figure 14.



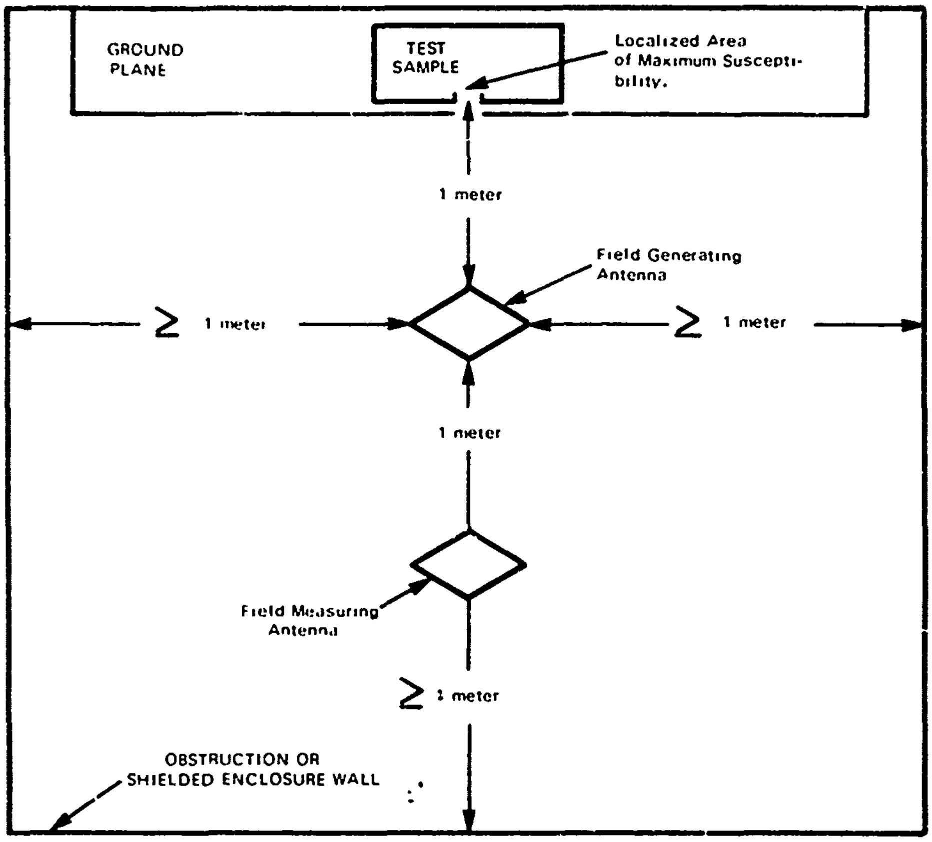
CONNECT A CALIBRATED 5 ohm NON-INDUCTIVE LOAD
RESISTOR TO GENERATOR TO VERIFY SPIKE
CHARACTERISTICS

FIGURE 29 CALIBRATION OF SPIKE GENERATOR



LIMIT FOR CS06 NOTE - E = 100 VOLTS (PEAK)
t - 10 MICROSECONDS

FIGURE 30 CONDUCTED SUSCEPTIBILITY (SPIKE)



NOTES:

(1) Through (3) of Figure 21 apply.

(4) The antennas shall be positioned so that the field-measuring antenna does not pick up reflections from the test sample.

FIGURE 31 PLACEMENT OF ANTENNAS FOR RADIATED SUSCEPTIBILITY MEASUREMENTS

C. Apparatus –

(1) Radiating Loop – The radiating loop shall be as shown in Figure 1A of MIL-STD-461A. The loop can produce a magnetic flux density of 5×10^{-5} tesla/ampere at a point approximately 5 cm from the face of the loop. It shall be supported by a nonmagnetic conductive material.

(2) Signal Source – The signal source shall be capable of supplying the loop with enough current to produce magnetic flux densities 20 to 30 dB greater than the applicable specification limit at the test frequency.

(3) The EMI meter, or narrowband VTVM, must be capable of reading levels as low as 30 μV in the test frequency range and must have a bandwidth of 10 Hz or less at the 3 dB points.

D. Test Procedure –

(1) Position the field radiating loop 5 cm from the surface of the test sample. The plane of the loop shall be parallel to the plane of the test sample's surface. (Figure 13.)

(2) At a frequency of 45 Hz, supply the loop with sufficient current to produce magnetic flux densities approximately 20 to 30 dB greater than the applicable limit at the test frequencies (132 dB/picotesla).

(3) Move the loop over the entire test sample surface and signal input and output cables and connectors to determine the point at which the applied field produces the maximum effect on the test sample.

(4) With the loop at the point of maximum susceptibility, adjust the loop current until the performance of the computer is not affected by applied field.

(5) Record the magnitude of the magnetic field density produced by the source and the maximum value of magnetic flux density required by step (4) above.

(6) Repeat steps (1) through (5) at the test frequencies shown below:

100 Hz	1 kHz	8 kHz
200 Hz	2 kHz	12 kHz
700 Hz	4 kHz	20 kHz

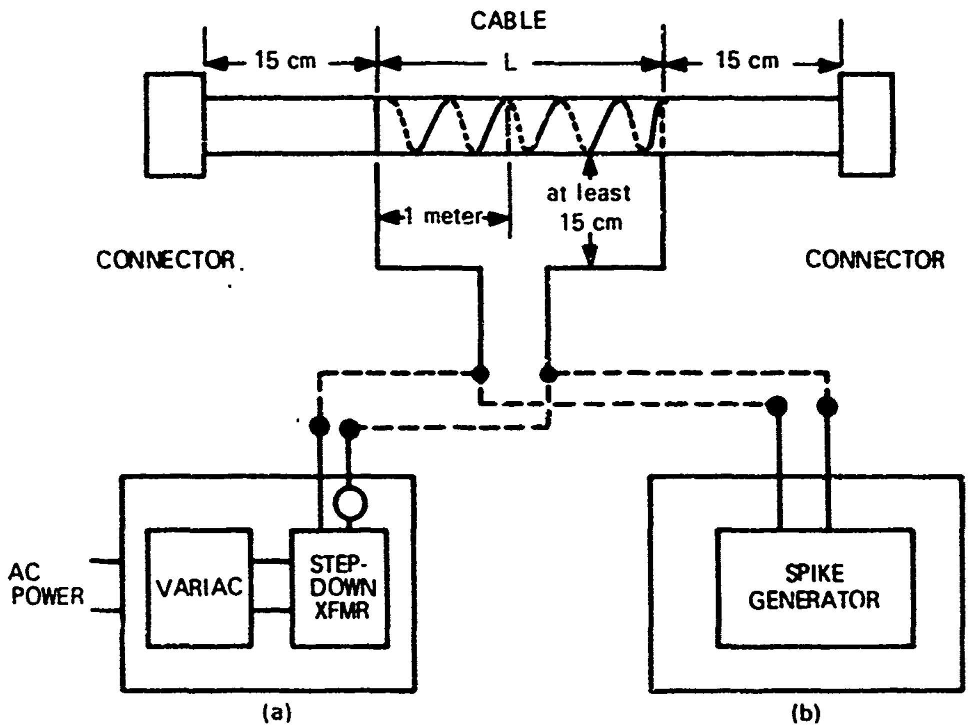
6.5.2 RADIATED SUSCEPTIBILITY, MAGNETIC INDUCTION FIELDS (RS02)

A. Test configurations are shown in Figures 32 and 33.

B. Limits – Power frequency test – 20 amperes at the power frequency.

C. Apparatus –

(1) Spike generator – Spike generator shall be as specified in 6.4.3 of this document.



NOTE: (1) L shall be the length of the cable in the actual installation or 1.5 meters, whichever is less.

FIGURE 32 RADIATED SUSCEPTIBILITY MAGNETIC INDUCTION FIELD, CABLE TEST

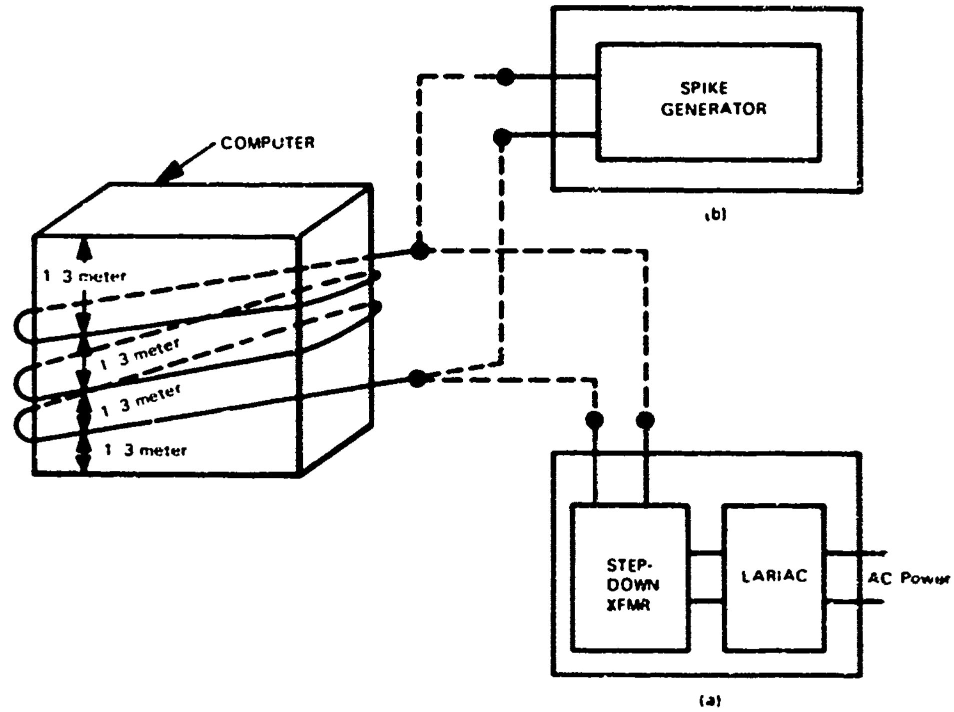


FIGURE 33 RADIATED SUSCEPTIBILITY, MAGNETIC INDUCTION FIELD CASE TEST

(2) Step-down transformer and variac – The step-down transformer and variac shall be capable of carrying the currents required by this test.

(3) Oscilloscope -

D. Test Setup and Procedures –

(1) Cable susceptibility test (Test 1) – The cable susceptibility test shall be performed as specified below.

(2) Power Frequency Test - Tape two current-carrying insulated wires to each wire bundle in the test setup with the current-carrying wire around the digital display leads, spiralling at two turns per meter (equally spaced) and running the entire length of the bundle to within 15 cm of each end connector. (See Figure 32.) Apply 20 amperes current at the test sample power frequency (60 Hz) to one test wire at a time. Monitor for susceptibility.

(3) Spike Test – Set up the test as shown in Figure 32. Repeat the procedure described in (2) above, applying the 100-volt spike, and monitor for susceptibility.

(4) Case Susceptibility Tests (Test 2) – The case susceptibility test shall be performed as specified below.

(5) Case Test - Wrap several turns of insulated wire around the computer cabinet. These turns should be located as shown in Figure 33 and held in place by tape. Apply 20-ampere current at 60 Hz through the wire, and monitor the computer display for changes in indication.

(6) Spike Test – Set up the test as shown in Figure 33. Repeat the procedure described in (2) above, applying the 100-volt spike, and monitor for susceptibility.

E. Notes

(1) AC power input and output leads are exempt from the cable test.

(2) Current-carrying wires should be kept 15 cm away from cable connectors.

(3) All cables should be at least 5 cm above the ground.

(4) The power frequency used for test purpose is 60 Hz.

6.5.3 RADIATED SUSCEPTIBILITY - ELECTRIC FIELD (RS03)

A. Test configuration is shown in Figures 15 and 31. Replace the EMI meter with the appropriate signal generator. The antennas shall be those specified in 6.1.3.2C.

B. Limits The field strength shall be 1 v/m in the frequency range of 14 kHz to 1.0 GHz.

C. Test Procedure –

(1) Test signals shall be selected before the test based on their clock frequency and harmonics.

(2) Fields shall be generated, as required, with the antennas specified in 6.2.3C. Care shall be taken that the test monitoring equipment is not affected by the test signals.

(3) The output of the signal generator shall be adjusted so that the generated fields at the test sample correspond to the applicable limit of 1 v/m. The specified field strength shall be established by placing a field measuring antenna at the same distance or at the relative location where the test sample will be placed. The power required at the input terminals of the transmitting antenna to establish the specified field shall be monitored and recorded. When a test is performed, this same power shall be applied to the transmitting antenna terminal.

(4) Determine those frequencies at which the test sample is susceptible. At these frequencies, determine the threshold of susceptibility. Record all pertinent data.

7.0 SUSCEPTIBILITY CRITERIA

In all susceptibility tests, each display group should present the same information and should be unchanging.

8.0 TEST INSTRUMENTATION

8.1 LIST OF INSTRUMENTATION

Interference Measuring Equipment

EMC-10, Fairchild, 20 Hz - 50 kHz S/N 69
NF-205, Empire Devices
T-X/NF-205 Tuning Head, 14 kHz - 150 kHz, S/N U08280
T-A/NF-205 Tuning Head, 150 kHz – 30 MHz, S/N U101030
T-1/NF-205 Tuning Head, 20 MHz - 200 MHz, S/N U-08281
T-2/NF-205 Tuning Head, 200 MHz – 400 MHz, S/N U-08282
NM-52A Stoddart, 375 MHz – 1 GHz, S/N 292-45
FIM-B2 Polarad, 1 GHz 10 GHz, S/N 301-284
6640, EMCO, 0.1 Hz - 50 kHz, S/N 10

Current Probes

GCP 5120 Genisco, 10 Hz – 15 MHz, S/N 180
GCP 5120 Genisco, 10 Hz - 15 MHz, S/N 144
GCP 5130 Genisco, 15 kHz - 50 MHz, S/N 121
GCP 5130 Genisco, 15 kHz 50 MHz, S/N 121(a)
GCP 5140 Genisco, 25 MHz - 400 MHz, S/N 156
GCP 5140 Genisco, 25 MHz - 400 MHz, S/N 111

Coaxial Switch

Bird Model No. 74

Feedthrough Capacitors

Genisco Model GF 4150-1

Antennas

VR-205, 14 kHz – 150 kHz, Vertical Rod
VA-205, 150 kHz – 30 MHz, Vertical Rod
Loop (Magnetic) – MIL-STD-461
Biconical – MIL-STD-461
Conical Logarithmic Spiral – MIL-STD-461 (Drawing 62J4040)
Conical Logarithmic Spiral – MIL-STD-461 (Drawing 62J4041)

Audio Oscillator

HP-200 CD Hewlett-Packard, 5 Hz – 600 kHz, S/N 103-33036

Power Amplifier

MC-60, McIntosh, 10 Hz – 100 kHz, S/N 3F-858

Oscilloscope

Type 546A Tektronix, S/N 029290

Spike Generator

Genisco Model SG-1

Variac

General Radio, Type W10G3M

Stepdown Transformer

Genisco Model T-1

Ammeter

0-40 Amperes, 60 Hz

Signal Generators

Hewlett-Packard, HP 606A, 50 kHz – 65 MHz, S/N 038-0216
Hewlett-Packard, HP 608A, 10 MHz – 500 MHz, S/N 1025
Hewlett-Packard, HP 612A, 450 MHz – 1.26 GHz, S/N 34
Hewlett-Packard, HP 4204, 10 Hz – 1 MHz, S/N 364

Calibrator, Magnetic Field

EMCO Model 6402, Helmholtz Coil System

8.2 INSTRUMENTATION CALIBRATION

All test equipment will be calibrated and certified to be within manufacturers' tolerances in accordance with the requirements of MIL-C-45662A as implemented by the Smith Calibration Policy Manual. Equipment model, serial number and date of last calibration will appear in the test equipment list submitted with the test report.

9.0 EMI TEST REPORT FORMAT

A. Format of the test report shall be as specified in MIL-STD-831 with the modifications that follow.

B. Cover page is required.

C. Administrative data shall include but not be limited to the following:
   (1) Test performed by prime supplier or by an independent testing laboratory.
   (2) Contract number.
   (3) Authentication – By supplier personnel who are responsible for

performance of the tests and for witnessing an organization's representatives.

(4) Disposition of the test specimen.

(5) Descriptions of the test specimen, function and intended use. Installation, if known, shall be included.

D. A separate appendix shall be included for each test. Each appendix shall contain the applicable test procedure, data sheets, graphs, illustrations, and photographs. The log sheets shall be in a separate appendix, which will be the last one. Definitions of specialized terms or words shall be contained in another appendix.

E. Content of the test report shall include the following information:

(1) Nomenclature of interference measuring equipment.

(2) Serial numbers of interference measuring equipment.

(3) Date of last calibration of interference measuring equipment.

(4) Photographs or diagrams of test setup with identification of instrumentation and test sample.

(5) Transfer impedance of current probes.

(6) Antenna factors of specified antennas.

(7) Measured level of emission or susceptibility at each frequency, before and after the application of suppression devices.

(8) Graphs or X-Y recordings of applicable limits and measured data in units specified in the applicable standard for that limit.

(9) Data specified in Figure 6.

(10) If suppression devices are used to meet the contractual requirements, they shall be identified using schematics, performance data, and drawings, except where these items are in other documents required by the contract.

(11) Sample calculations, if any.

(12) Measured power-line voltage during test.

(13) Discussion of frequency selection if different from test plan.

(14) Ambient level at each measured frequency.

F. Recommendations and conclusions shall include results of the tests in brief narrative form, a discussion of remedial actions already initiated, and proposed corrective measures to assure compliance of the equipment or subsystem with the contractual EMI requirements.

G. Interservice Data Exchange Program (IDEP). Reports submitted for the IDEP may conform to any applicable special requirement as specified in the contract.

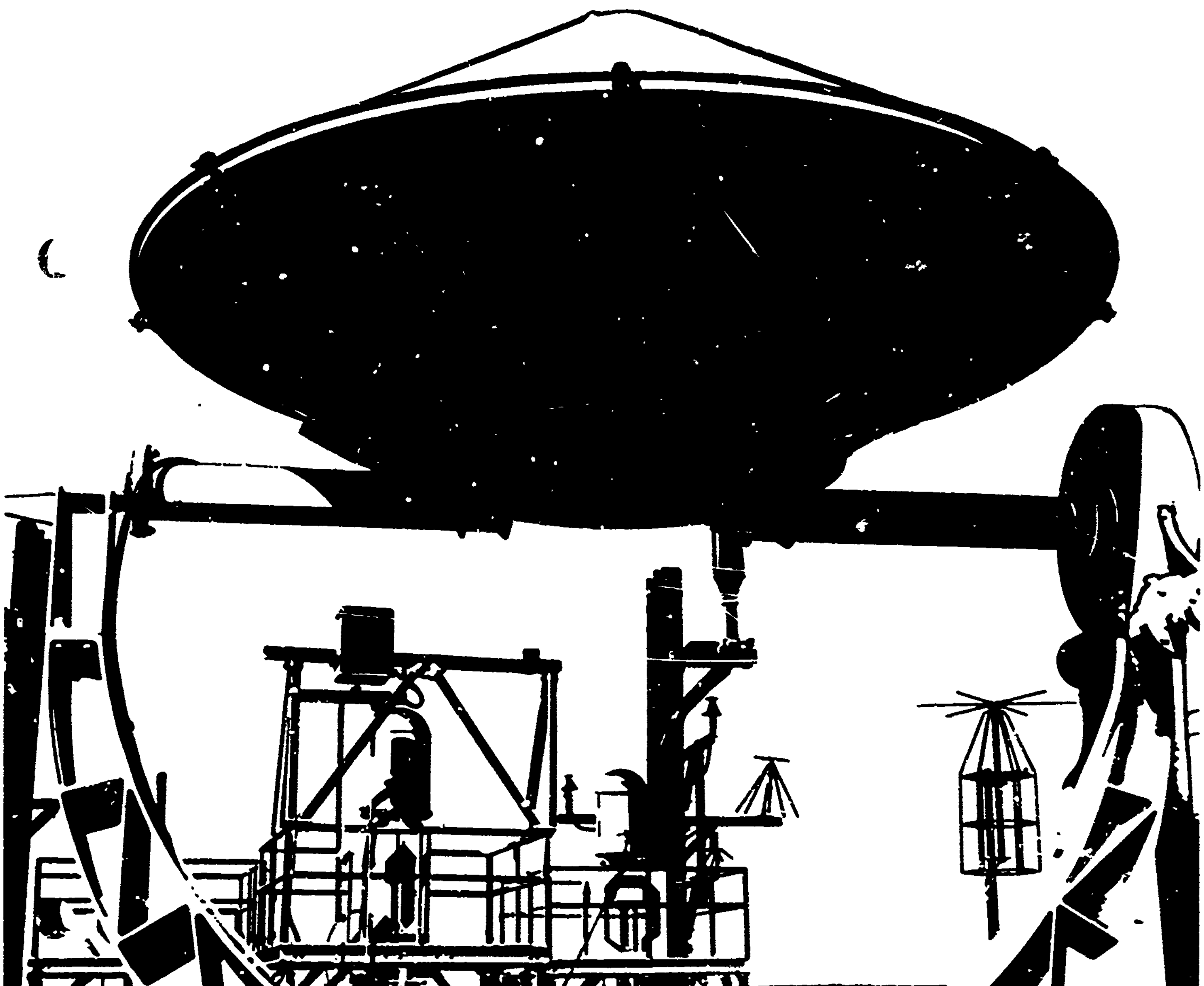
NAVAIR 5335

NAVAL AIR SYSTEMS COMMAND

ELECTROMAGNETIC COMPATIBILITY MANUAL

APPENDIX E

GLOSSARY, DEFINITIONS, AND ABREVIATIONS



PUBLISHED BY DIRECTION OF COMMANDER, NAVAL AIR SYSTEMS COMMAND

APPENDIX E

GLOSSARY, DESIGNATORS, AND ABBREVIATIONS

CONTENTS

I. GLOSSARY

A

Absorption – The transfer of electromagnetic energy to a substance being traversed.

Absorption loss – That part of the transmission loss due to the dissipation or conversion of either sound energy or electromagnetic energy into other forms of energy (e.g. heat) either within the medium or attendant upon a reflection. (IRE)

Accessibility – The ease of admission to an area for the performance of visual and manual maintenance.

Accessory – A part, an assembly, or subassembly designed for use in conjunction with, or to supplement, another assembly, unit or set, contributing to the effectiveness thereof without extending or varying the basic function of the assembly or set. An accessory may be used for testing, adjusting, or calibrating. (Examples: Test instrument, recording camera for radar set, headphones, emergency power supply.)

Active maintenance time – The time during which preventive or corrective maintenance work is actually being done on the item.

Active repair time – The time during which technicians work to repair an item.

Active technician time – The time expended by technician(s) in active maintenance. Expressed in man-hours, not calendar time.

Adcock antenna – A pair of vertical antennas separated by a distance of one-half wavelength or less, and connected in phase opposition to produce a radiation pattern in the shape of a figure eight.

Adjacent channel – The channel immediately above or below the desired channel.

Adjustment and calibration time – That element of active maintenance time required to adjust or calibrate the item to place it in a specified condition.

Administrative time – That portion of non-active maintenance time that is not included in supply time.

Advanced development objective (ADO) – A requirement document prepared by CNO stating a need to conduct certain experimental studies, test and development effort. (OPNAV – 3900.8C)

Agency – 1. As officially used for the government as a whole, any executive department, military department, commission, authority, administration, board, or other independent establishment in the executive branch of the government, including any corporation, wholly or partly owned by the United States, which is an instrumentality of the United States. Excludes the District of Columbia.

2. Loosely used to designate a subordinate organizational subdivision of the Department of Defense and the military departments. (DOD 5000.8)

Airframe – The assembled structural and aerodynamic components of an aerospace vehicle that support the different systems and subsystems integral to the vehicle.

Alert time – That time when an item is available to perform a mission. (Different from ready time.)

Alford antenna – A resonant square-loop antenna formed by four linear sides with their ends bent inwards to provide capacitive loading that equalizes the current round the loop.

Allotment – 1. An authorization by the head or other authorized employee of an agency to incur obligations within a specified amount pursuant to an appropriation or other statutory provision.

2. In the Department of Defense, the word has a more limited significance; in addition, the word means:

a. that the authority is granted by an operating agency to another office, generally one subordinate to it, within and pursuant to an allocation or other similar authority granted to it, and

b. that the granting of such authority must be rigidly formal and subject to certain specific procedural bookkeeping and reporting requirements. Hence, other forms of allotments are distinguished by other words, such as suballotments, obligation authority, citation of funds.

3. Definite portion of pay to military personnel which is authorized, either voluntarily or by law, to be paid to another person or to an institution. (Project 60)

Alternate radio channels – The first alternate channel is the second from the desired channel on either side. The second alternate channel is the third channel from the desired channel on either side.

Ambient electromagnetic environment – The level of electromagnetic emission (conducted or radiated) indicated by a calibrated interference-measuring set with the equipment under test inoperative.

Ampere – A unit of electric current equivalent to the flow of one coulomb per second or to the steady state current produced by one volt applied across a resistance of one ohm.

Amplifier – A device used to increase the signal voltage, current, or power.

Analysis, cost effectiveness – A method of selecting weapons and forces that will provide the greatest military effectiveness for a given cost. (NAVEXOS P-2426A)

Analytical outputs – The final calculations, statements, or conclusions resulting from an analysis.

Analytical tools – Theoretical or empirical processes used in performing an analysis.

Anechoic enclosure – Originally used to describe audio frequency low reflection enclosures. Now applied generally to low reflection enclosures. May be supplemented with EMI shielding.

Angular frequency – The frequency expressed in radians per second. It is equal to the frequency in hertz multiplied by 2π.

Annexes, program – Detailed lists of specific requirements of the five-year programs. (DOD 7045.1)

Anomalies – Deviations from the general rule or expected order or inconsistencies in them.

Antenna – A device for radiating or receiving radio-frequency energy.

1. System antenna – The antenna whose characteristics are being measured.

2. Test antenna – The antenna associated with the measurement equipment.

Antenna conducted emission – The undesired portion of signal spectrum present at the antenna terminal, created by an operating receiver or a transmitter in standby condition.

Antenna conducted emission, transmit condition – The undesired portion of signal spectrum appearing at the antenna terminal of a transmitter under full load transmit condition.

Antenna factor – A multiplying factor applied to the voltage at the input terminals of the measuring instrument to yield electric field strength in volts/meter and magnetic field strength in amperes/meter, for a given antenna and frequency.

Antenna gain – The ratio of the maximum radiated power intensity from the subject antenna to the maximum intensity from a reference antenna with the same power input. Choosing an ideal lossless isotropic radiator as reference allows gain to be expressed as the ratio of maximum radiated power intensity to average intensity. Unless otherwise specified, the comparison antenna is isotropic.

Antenna, isotropic – An antenna with equal radiation or reception in all directions. Although such an antenna cannot be constructed, it is a concept of great convenience because of its mathematical simplicity.

Antenna pattern – A diagram of the radiation field of an antenna, usually in terms of loci representing equal power levels. The radiation characteristics vary inversely as the square of the distance and depend on direction from the source.

Antenna polarization – The variation of an electric field vector in any electromagnetic wave. In general, vertical antennas produce vertically polarized electric waves, while horizontal antennas produce horizontally polarized electric waves. Linear receiving antennas must be parallel in the direction of polarization to receive maximum power, for plane waves incident in a given direction. The polarization of the incident wave is that which, for a given amplitude, induces the maximum voltage across the antenna terminals.

Antenna resistance – The quotient of the power supplied to the entire antenna circuit by the square of the effective antenna current referred to a specified point.

NOTE. Antenna resistance is made up of such components as radiation resistance, ground resistance, radio-frequency resistance of conductors in the antenna circuit, and equivalent resistance due to corona, eddy currents, insulator leakage, and dielectric power loss.

Aperture – (of a unidirectional antenna) That portion of a plane surface near the antenna, perpendicular to the direction of maximum radiation, through which the major part of the radiation passes.

Appraisal – An essential part of the planning and programming performed at all decisive stages of the process. Appraisal includes determining what information is necessary for decision at a given control level; ensuring that this information is available from supporting information systems; screening and evaluating this information to determine its significance; and finally, presenting the information so that it will help in decision making. (OPNAV 5000.19E)

Appropriation – An appropriation is an authorization by an Act of Congress to incur obligations for specified purposes and to make payments out of the Treasury. Appropriations are subdivided into budget activities, sub-heads, programs, projects.

Appropriation sponsor – The DCNO or a director of a major staff office charged with supervisory control over an appropriation.

Approved programs – Resources for individual program elements or data reflected in the FYDP as modified by Program Change Decisions (PCDs), Program/Budget Decisions (PBDs), other Secretary of Defense decisions, or below-threshold changes approved by the head of a DOD component. NOTE. For PCR preparation, the "approved program" is a specific DoD approved update of the FYDP, the DNFYP (Blue Streak) of the same date.

Armed Services Procurement Planning Officer (ASPPO) – Staff member of a military field office who is assigned one or more plants for which he coordinates all Army, Navy, Air Force, Defense Supply Agency, and Maritime Administration production planning for the Department of Defense. (Project 60)

Assembly – A number of parts or subassemblies or any combination thereof joined together to perform a specific function. (Power shovel-front, fan assembly, audio-frequency amplifier.)

NOTE. The distinction between an assembly and a subassembly is not always exact – what is an assembly in one instance may be a subassembly in another, where it forms a portion of an assembly.

Atmospheric duct – An almost horizontal layer in the troposphere extending from the level of a local minimum of the modified refractive index as a function of height, down to a level where the minimum value is again encountered, or down to the earth's surface if the minimum value is not again encountered.

Atmospheric interference – Interference from sources such as precipitation static, frictional charging, and thunderstorms.

Attachment – A part, subassembly, or assembly designed for use in conjunction with another assembly, unit or set, contributing to the effectiveness thereof by extending or varying the basic function of the assembly, unit or set. (Hoisting attachment on a truck, milling attachment for a lathe.)

Attenuation – 1. A general term used to denote a decrease in magnitude in transmission from one point to another. It may be expressed as a ratio or by extension of the term in decibels. (ASA)

2. The reduction in the flux density, or power per unit area, with distance from the source; it may be due to absorption, to scattering, or to both.

Attenuator – A device for reducing the amplitude of a wave. Attenuators are usually combinations or networks of either fixed or adjustable resistances. In its many different forms and applications, the attenuator becomes known variously as pad, gain control, level adjustor, volume control.

Atto – A prefix meaning multiplied by 10^{-18}.

Augmented support – An interim arrangement during initial development or production of an equipment whereby the contractor is obligated to furnish to the Government, either from production or from stocks maintained by him, items for the support of the equipment pending assumption of support responsibility by the Government.

Authority – 1. The power or right to act or command, or to demand obedience.

2. An individual, organization, or office possessing and exercising such power.

3. One who, by virtue of his position in an organization or by his reputation as an expert in a given area, is empowered or regarded as competent to decide a question.

NOTE When authority is delegated downward in a chain of command commensurate with responsibilities assigned, such delegation does not relieve the superior of responsibility. (Project 60)

Automatic Data Processing (ADP) – The processing (classifying, sorting, calculating, summarizing, recording, printing) of data through the use of electronic digital computers, communications channels and devices used with such computers, and associated peripheral equipment. Includes preparation of source data in form appropriate for such processing. (DOD 5000.8)

Automatic Frequency Control (AFC) – A circuit that generates a low frequency correction to maintain the intermediate frequency at its correct value (performed by modulating the local oscillator at an audio rate to provide a carrier).

Automatic Gain Control (AGC) – A method of automatically obtaining a constant output of some amplitude characteristic to overcome variations of that characteristic at the input signal. The term is also applied to a device that does this.

Availability (achieved) – The probability that a system or equipment, when used under stated conditions in an ideal support environment (i.e., available tools, parts, manpower, manuals) will operate satisfactorily at any given time. A_a excludes supply downtime and waiting or administrative downtime. It may be expressed as:

$$A_a = \frac{MTBM}{MTBM + \bar{M}}$$

where

MTBM = Mean time between maintenance and ready time during the same time interval, and

$\bar{M}$ = Mean active maintenance downtime resulting from both preventive and corrective maintenance.

Availability (inherent) – The probability that a system or equipment, when used under stated conditions without consideration for any scheduled or preventive maintenance, in an ideal support environment (i.e., available tools, parts, manpower, manuals) will operate satisfactorily at any given time. A_i excludes ready time, preventive maintenance downtime, supply downtime, and waiting or administrative downtime. It may be expressed as:

$$A_i = \frac{MTBF}{MTBF + MTTR}$$

where

MTBF = Mean time between failure, and

MTTR = Mean time to repair.

Availability (operational) – The probability that a system or equipment when used under stated conditions and in an actual supply environment will operate satisfactorily at any given time. It may be expressed as:

$$A_o = \frac{MTBM}{MTBM + MDT}$$

where

MTBM = Mean time between maintenance and ready time during the same time interval, and

MDT = Mean downtime including supply downtime and administrative downtime during the same time interval. When preventive maintenance downtime is zero or not considered, MTBM becomes MTBF.

Average power – When applied to pulse radar techniques, the product of the peak power transmitted and the fraction representing the time duration in seconds of the pulse. Thus, a pulse of 500,000 watts peak power transmitted for 1/1000 second yields an average power of 500 volts.

Avionic – The term "avionic" as used in NAVAIRSYSCOM is derived from the words "aviation electronic" and is used as an adjective to describe electronic equipments and systems developed for use in, or for support of manned aircraft, unmanned aircraft, missiles, and space vehicles. Avionic equipments and systems are used to meet a variety of operational requirements such as antisubmarine warfare, search detection and localization, communications, surveillance, identification, navigation, countermeasures (active or passive), guided missile control, and space vehicle operations.

Azimuth – 1. A direction expressed as a horizontal angle usually in degrees or mils and measured clockwise from north. Thus azimuth will be true azimuth, grid azimuth, or magnetic azimuth depending upon which north is used.

2. The angle at the zenith between the observer's celestial meridian and the vertical circle through a heavenly body.

B

Balanced line – A balanced or "metallic" line or circuit using two conductors or components instead of one conductor or component and ground (common conductor). The two sides of the line are symmetrical with respect to ground. Line potentials to ground and line currents are equal but of opposite phase at adjacent points along the line. A balanced line is preferred for minimum noise and crosstalk.

Balun – 1. An antenna-matching device used to permit efficient coupling of a transmitter or receiver having an unbalanced output circuit to an antenna having a balanced transmission line; consists of two bifilar-wound inductors.

2. A device for converting balanced to unbalanced transmission lines and vice versa, by placing suitable discontinuities at the junction between the lines instead of using lumped components.

Band elimination filter – A filter that attenuates signals significantly in the f[illegible]quency band between specified cutoff points ("stop" band) and transmits all frequencies above and below them (complementary to band-pass filter).

Bandpass filter – A filter that transmits signals with relatively low attenuation in the frequency band between specified cutoff frequencies ("pass" band) and attenuates frequencies above and below them. Neither of the cutoff frequencies is zero or infinite.

Bandpass response – A response characteristic that exists when a definite band of frequencies is transmitted uniformly.

Band-stop filter – Filter having characteristics that reject frequencies within a defined band and offer low attenuation of those outside.

Bandwidth – 1. The nominal bandwidth is the maximum band of frequencies, inclusive of guard bands, assigned to a channel.

2. The range of frequencies within which the performance, in respect to some characteristic, conforms to a specified standard.

Baseband – 1. In modulation, the baseband is the frequency band occupied by the aggregate of the modulating signals when first used to modulate a carrier.

2. The frequencies containing the intelligence used to modulate the carrier of a communications system.

Base fiscal year – That fiscal year arrived at by adding one to the current calendar year.

Batwing antenna – Slot antenna with flanges having batwing shape to control radiation pattern.

Baud – 1. A unit of signalling speed equal to the number of code elements per second.

2. The unit of signalling speed equal to twice the number of Morse code dots continuously sent per second.

3. The unit of modulation rate. The modulation rate is expressed as the reciprocal of the duration in seconds of the unit interval. Example. If the duration of the unit interval is 20 milliseconds, the modulation rate is 50 bauds.

Beacon, radio A radio transmitter that emits a disti... or characteristic signal used for the determination of bearings, courses, or location.

Bel – A dimensionless unit for expressing the ratio of two values of power, the number of bels being the logarithm to the base 10 of the power ratio. With P_1 and P_2 designating two amounts of power and N the number of bels corresponding to the ratio P_1/P_2, $N = \log_{10}(P_1/P_2)$.

Biconical antenna – An antenna formed by two conical conductors having a common axis and vertex and excited at the vertex. When the vertex angle of one of the cones is 180°, the antenna is called a discone.

Binary – A characteristic, property, or condition in which there are but two possible alternatives: e.g., the binary number system using 2 as its base and using only the digits (0) and (1).

Bit – 1. An abbreviation of binary digit.

2. A single character in a binary number.

3. A single pulse in a group of pulses.

4. A unit of information capacity of a storage device. The capacity in bits is the logarithm to the base two of the number of possible states of the device.

Black box – 1. In engineering design, a unit whose output is a specified function of the input but for which the method of converting input to output is not necessarily specified.

2. Colloquially, any unit, usually an electronic device such as an amplifier, which can be mounted in or removed from a rocket, spacecraft, or the like as a single package.

Blanking pulse – A pulse used to remove the lines that would otherwise be traced on a cathode-ray tube during the retrace time or flyback time (the time during which the electron beam returns to start another line or trace).

Blinders – Shields at the sides of an antenna aperture.

Blue Streak – A common expression for the official Navy document displaying the Department of the Navy Five-Year Program (DNFYP).

Bolometer – A specially constructed resistor which has a positive temperature coefficient and which is used for power measurements.

Bond – Any fixed union existing between two metallic objects that results either from physical contact between conductive surfaces or the subjects, or from the addition of a firm electrical connection between them.

Bond, direct – The joining of two metallic surfaces by welding, brazing, or soldering.

Bond, indirect – The joining of two metallic surfaces by a low impedance conductor.

Bonding – 1. Bonding is the process of physically providing a low impedance connection between two metallic surfaces.

2. Aircraft electrical bonding is the process of obtaining the necessary electrical conductivity between metallic parts of the aircraft.

Bonding connector – A bonding connector provides the desired electrical conductivity between metallic parts in an airplane.

Boundary considerations – Analysis of electromagnetic wave phenomena occurring at or near discontinuities in the transmission media.

Bow Tie antenna – A dipole or slot antenna formed by two triangular areas in a bow tie configuration.

Brassboard model – An evolution of the breadboard to meet mechanical as well as electrical design specifications.

Breadboard model – An uncased assembly of an instrument or piece of equipment with the parts laid out on a flat surface and connected so as to permit checking or demonstrating its operation, or an assembly of preliminary circuits and parts to prove the feasibility of a device, circuit, equipment, system, or principle in rough form without regard to the eventual overall design or form of parts.

Breakout 1. As used in this document, the process whereby parts, components, assemblies, subassemblies, sets, or groups are selected for direct competitive procurement. Example: The selection of a major item from material involved in production contracts (i) which the Government will supply to the contractor as Government Furnished Material (GFM) or (ii) which the contractor will be encouraged to procure competitively.

2. A program that provides for the systematic analysis of high value equipment or systems to determine if the competitive procurement of major components by

the Government or prime contractor is feasible.

Broadband emission – A signal emission having a spectral power distribution in which the impulse bandwidth of the measuring instrument is more than 1.2 times the repetition frequency of the signal when the impulse bandwidth of the receiver is also less than 1/t, where t is the pulse width of the signal. For practical use in determining narrowband or broadband classification of emissions, detune the instrument by one impulse bandwidth or by one-half of the smallest frequency dial division, whichever is larger. If the peak reading is reduced by at least 3 dB, classify it as narrowband. If the peak reading does not decrease at least 3 dB, classify it as broadband. Note that this criterion makes classification as narrowband or broadband a function of the bandwidth of the measuring instrument.

Broadband interference – Includes impulse noise, thermal noise, shot noise, and other nonsinusoidal interference whose energy is distributed over a spectrum of frequencies that is wide when compared with the bandwidth of the interference measuring equipment. The response of an interference measuring set to broadband interference is a function of the effective bandwidth of the receiver.

Budget – 1. A planned program for a fiscal period in terms of

a. estimated costs, obligations and expenditures

b. source of funds for financing, including reimbursements anticipated and other resources to be applied and

c. explanatory and workload data on the projected programs and activities.

2 To prepare such a program. (Project 60)

Butterworth response – A filter response approximating the ideal filter response characterized by a flat amplitude approximation within the pass band and the stop band. The approximation is relatively poor in the vicinity of cutoff.

C

Cage antenna – Thick dipole (or monopole) of uniform or non-uniform section constructed of wires held by horizontal rings.

Calibrate – To ascertain, usually by comparison with a standard, the locations at which scale, chart, or record graduations should be placed to correspond with a series of values of the quantity that an instrument is to measure.

Capture effect – An effect in FM reception in which the stronger signal of two stations completely suppresses the weaker signal.

Card, eighty column – A punch card with 80 vertical columns representing 80 characters. Each column is divided into two sections, one with character positions labeled zero through nine, and the other labeled eleven and twelve. The 11 and 12 positions are also referred to as the X and Y zone punches, respectively.

Carrier – 1. A carrier is a wave suitable for modulation by the intelligence to be transmitted over a communication system. The carrier can be a sinusoidal wave or a recurring series of pulses.

2. In a frequency stabilized system, the sinusoidal component of a modulated wave whose frequency is independent of the modulating wave; or the output of a transmitter when the modulating wave is made zero; or a wave generated at a point in the transmitting system and subsequently modulated by the signal; or a wave generated totally at the receiving terminal which, when combined with the side bands in a suitable detector, produces the modulating wave. (FCC Rules and Regulations Part 2.1)

Carrier frequency – The carrier frequency is the frequency of the unmodulated carrier wave, if sinusoidal, or the center frequency of the unmodulated carrier when a recurring series of pulses is used.

Carrier noise level – The noise level produced by undesired variations of a carrier in the absence of any intended modulation.

Carrier power output rating – The unmodulated power nominally available at the output terminals of th. tr. nsmitt r when connected to its normal antenna, or to a circuit equivalent thereof. Unless otherwise stated, this is the normal rating of the transmitter.

Carrier shift – A condition resulting from imperfect modulation that causes a change of carrier power in amplitude modulation.

Cavity resonator – A space normally bounded by an electrically conducting surface in which oscillating electromagnetic energy is stored, and whose resonant frequency is determined by the geometry of the enclosure.

Cell-type enclosure – A pre-fabricated basic shielded enclosure of double-walled, copper-mesh construction. The original screen room design.

Channel – 1. A facility for telecommunications on a system or circuit. The number of independent channels on a system or circuit (derived by frequency or time division) is measured by the number of separate communication facilities that can be provided by it.

2. The band of frequencies within which a radio transmitter must maintain its modulated carrier signal.

NOTE: The term channel is also used frequently in conjunction with figures or letters to identify a particular facility between two stations.

Characteristic – Frequently used to indicate the frequency-versus-amplitude response chart of almost any piece of equipment or any part of a transmission circuit, i.e., amplifier characteristic, equalizer characteristic, line characteristic.

Characteristic impedance – 1. The characteristic impedance of any line is the impedance that would be measured if that line were uniform in all respects throughout its length and of infinite length. This is to say that the line is so long that the measuring instruments cannot detect the presence or absence of any discontinuity such as a distant end. When one speaks of an open-wire impedance of 600 ohms or a cable impedance of 125 ohms, "characteristic" is implied.

2. The ratio of the voltage to the current at every point along a transmission line on which there are no standing waves.

Charter, project – The official document promulgated by the chartering authority establishing the designated project and appointing an individual by name as the project manager, defining his authority and responsibility, together with limitations, if any. The charter includes the resources, program elements and parts thereof, and facilities and manpower available to the project manager and approved for the project. The charter also specifies the interfaces with other designated projects or non-designated projects and describes the operating relationships between the project manager and other participating organizations concerned with or involved in the project. (NAVMAT 5000.5A)

Chassis, electrical equipment – The chassis is a structural item of electrically conductive material fabricated to facilitate assemblage and interconnection of electrical or electronic items for the specific purpose of providing a basis for electrical or electronic circuits. It normally has drilled or stamped holes to accommodate the items but may include only the items necessary for its own mounting and support.

Chassis ground – The metal structure that supports electrical components that make up the unit or system. In practice, the chassis ground is considered an extension of the ground plane.

Chebyshev response – A filter response approximating the ideal filter response characterized by an equal ripple approximation whose passband amplitude response is an equal peak-to-peak deviation from the flat ideal filter response.

Checkout – A sequence of functional, operational, and calibrational tests to determine the condition and status of a weapon system or element of it.

Cheese antenna – A cylindrical parabolic reflector enclosed by two plates perpendicular to the cylinder, spaced to permit the propagation of more than one mode in the desired direction of polarization. It is fed on the focal line.

Chop – Expression indicating concurrence.

Circuit – 1. Communication term. An electronic path between two or more points capable of providing a number of channels.

2. Engineering term. A number of conductors connected to carry an electrical current.

Circuit malfunction analysis – The logical, systematic examination of circuits and their diagrams to identify and analyze the probability and consequence of potential malfunctions for determining related maintenance or maintainability design requirements.

Classification, defense security – A category or grade assigned to defense information or material that denotes the degree of danger to national security that would result from its unauthorized disclosure and for which standards in handling, storage, and dissemination have been established. These categories are: **Confidential** – Defense information or material, the unauthorized disclosure of which could be prejudicial to the defense interests of the Nation. Secret – Defense information or material, the unauthorized disclosure of which could result in serious damage to the Nation, such as by jeopardizing the international relations of the United States, endangering the effectiveness of a program or policy of vital importance to the national defense, or compromising important military or defense plans, scientific or technological developments important to national defense, or information revealing important intelligence operations. **Top Secret** – Defense information or material which requires the highest degree of protection. The top secret classification shall be applied only to that information or material the defense aspect of which is paramount, and the unauthorized disclosure of which could result in exceptionally grave diplomatic relations affecting the defense of the United States, an armed attack against the U S. or its allies, a war, or the compromise of defense classification of military or defense plans, or intelligence operations, or scientific or technological developments vital to the national defense. (Project 60)

Clear – 1. A message is in clear when it is not coded.

2. To restore a storage or memory device to a prescribed state, usually that denoting zero.

Clipping – 1. Mutilation of code signals or speech during transmission, resulting in suppression of the beginnings and endings of letters or syllables.

2. Removal of the upper and/or lower portions of a signal waveform by means of a limiter.

3. Limitation of the frequency bandwidth by the use of a filter.

Clipping circuit – A pulse-shaping network that removes the part of a waveform above or below a chosen voltage level, also called a clipper.

Clock – 1. A master timing device used to provide the basic sequencing pulses for the operation of a synchronous computer.

2. A register that automatically records the progress of real time or perhaps some approximation to it, records the number of operations performed, and whose contents are available to a computer program.

Clock pulse – One of a train of uniformly timespaced pulses used to establish a time reference rate or to provide synchronization within a computer or other digital processing system. In PCM systems, usually a timing pulse that occurs at the bit repetition rate.

Coaxial antenna – An antenna comprised of a quarter wavelength extension to the inner conductor of a coaxial line and a radiating sleeve, which is formed by folding back the outer conductor of the coaxial line for approximately one-quarter wavelength.

Coaxial cable – A transmission line consisting of one conductor, usually a small copper tube or wire within and insulated from another conductor of larger diameter, usually copper tubing or copper braid. The outer conductor may or may not be grounded. Coaxial cable is sometimes called concentric line or coaxial line.

Co-channel interference – Interference between two signals of the same type in the same communications channel.

Coding – 1. In communication or information theory, the translation of a message into a signal or symbol for processing or storage.

2. In human engineering, the design of controls and displays to facilitate their differentiation, identification, and efficient operation.

Cognizance, management – The responsibility for complete management direction, and coordination and application of technical direction of a system or program in achieving an objective. Management cognizance does not necessarily imply that the management cognizant agency performs all the functions involved in the responsibility. (BUSHIPS 5430.38)

Cognizance, technical – The responsibility for research, design, development, test, technical evaluation, production or construction of equipment, assemblies and parts. It includes responsibility for providing engineering services in specialty areas and criteria for installation, alteration, maintenance, repair, overhaul and refitting.

Commitment – A firm administrative reservation of funds, based upon firm procurement directives, orders, requisitions, or requests that authorize the creation of an obligation without further recourse to the official responsible for certifying the availability of funds. Differs from term used in business, where it means a contract or other legal obligation for goods or services to be furnished. (Project 60)

Communication-electronic (C-E) equipment – Any item using the electromagnetic medium to generate, transmit, acquire, receive, process, or distribute information, in the broadest sense.

Communication, radio – The use of radio for communication. It is technically described as telecommunication using radio waves not guided between the sender and receiver by physical paths such as wire or waveguides.

Compatibility – 1. The quality or characteristic of a piece of equipment or a system which permits it to function in harmony with other equipments or systems, e.g., electromagnetic compatibility, electronic compatibility.

2. In a missile, the quality of the overall system that enables all subsystems to function smoothly together or the characteristic of a major subsystem that enables it to function well in the overall missile system.

Complete provision for – "Complete provision for" or "provision shall be made for" a specific item or equipment, or assembly or installation, means that all supports, brackets, tubes, and fittings, electrical wiring, and hydraulic lines have been installed and adequate weight and space allocated so that the equipment can be installed without alteration to the specified equipment or the rotary wing aircraft, and that no additional parts are required for installation, other than the item itself. Standard stock items such as nuts, bolts, and cotter pins need not be furnished. The item of equipment, assembly, or installation shall be included in the Weight Empty unless specifically indicated or stated in the detail specification that the item is to be Useful Load or Special Equipment.

Component – 1. A self-contained unit necessary to the proper operation of the module, subsystem, or system of which it is a part; e.g., a receiver, gyroscope, or amplifier unit.

2. The smallest recognized unit (black box) that generally is used in conjunction with other components to perform a particular function.

Component pilot rework – The initial rework of selected items by the designated Government rework activity, a component rework capability concurrent with the assumption of support responsibility for the end article by the Government.

Computer listing – A listing of data that is extracted from a file, processed, and printed by the computer and its associated equipment.

Concept formulation (CF) – Describes the activities preceding a decision to carry out engineering development. These activities include accomplishment of comprehensive system studies and experimental hardware efforts under exploratory and advanced development, and are prerequisite to a decision to carry out engineering development. (DOD 3200.9)

Conductance – The characteristic of a body that allows electricity to flow through it. The unit of conductance is the mho. Electrical conductance varies with the dimensions of the conducting system and is the reciprocal of the electrical resistance.

Conducted electrical energy – Energy in the form of voltage or current variations that are detectable on electrical conductors including variations in power loading on equipment power lines.

Conducted emission – Desired or undesired electromagnetic energy that is propagated along a conductor. Such an emission is called "conducted interference" if it is undesired. MIL-STD-463

Conductive gasket – A special highly-resilient gasket which has one or more access openings and is used to reduce RF leakage in shielding.

Conductivity – Electrical conductivity is the reciprocal of electrical resistivity and is expressed in units such as mhos per centimeter. It is an intrinsic property of a given type of material under given physical conditions (dependent mostly upon temperature).

Conduit – A conduit is a metallic enclosure used to protect and support wires and cables of electrical and electronic systems and to attenuate radio frequencies to prevent electromagnetic interference.

Construction annex – A listing of major military construction projects that provides by fiscal year, the cost and location for each approved construction line item that exceeds one million dollars.

Contact finger – In shielding, this is one section of a separate strip of conductive metal used as a compression-wiping door and access port seal.

Contract, classified – Any contract that requires or will require access to classified information by the contractor or his employees in the performance of the contract. A contract may be classified even though the contract document itself is not classified. (Project 60)

Contract – 1. A contract that provides for payment to the contractor of allowable costs, to the extent prescribed in the contract, incurred in performance of the contract.

2. A cost-reimbursement type contract under which the contractor receives no fee. (Project 60)

Contract, Cost-Plus-Incentive-Fee (CPIF) – A cost-reimbursement type contract with provision for a fee which is adjusted by formula in accordance with the relationship which total allowable costs bear to target costs. The provision for increase or decrease in the fee, depending upon allowable costs of contract performance, is designed as an incentive to the contractor to increase the efficiency of performance. (Project 60)

Contract, cost-plus-a-percentage-of-cost – A form of contract formerly used, but now illegal for use by the military departments, which provided for a fee or profit at a specified percentage of the contractor's actual cost of accomplishing the work to be performed. Sometimes referred to as a "cost-plus" or "percentage-of-cost" contract. (Project 60)

Contract, cost-reimbursement type –

1. A type of contract which provides for payment to the contractor of allowable costs incurred in the performance of the contract, to the extent prescribed in the contract. This type of contract establishes an estimate of total cost for the purpose of obligation of funds and a ceiling which the contractor may not exceed (except at his own risk) without prior approval or subsequent ratification of the contracting officers.

2. Cost-reimbursement contracts include the following types:

a. cost contracts

b. cost-sharing contracts

c. CPFF contracts

d. CPIF contracts

e. facility (with limitations) (Project 60)

Contract, cost sharing – A cost-reimbursement type contract under which the contractor receives no fee but is reimbursed only for an agreed portion of its allowable costs. (Project 60)

Contract Definition (CD) – A formal procedure preceding full-scale development. During contract definition, preliminary engineering and contract and management planning are accomplished in order to arrive at realistic design characteristics, cost estimates, schedule estimates, definition of high risk areas, as well as definition of system interfaces and management responsibilities. The ultimate objective of contract definition is to permit firm fixed price or a fully structured incentive contract. (OPNAV 3900.8C)

Contract, Firm Fixed-Price (FFP) – A contract that provides for a price which is not subject to any adjustment by reason of the cost experience of the contractor in the performance of the contract. It is used for contracts awarded after formal advertising; also used in negotiated contracts when reasonably definite specification are available and costs can be estimated with reasonable accuracy to enable the negotiation of a fair price. Sometimes referred to as "lump-sum" contract in the area of construction of facilities. (Project 60)

Contract, fixed-price – A type of contract that generally provides for a firm price, or under appropriate circumstances may provide for an adjustable price, for the supplies or services being procured. Fixed price contracts are of several types so designed to facilitate proper pricing under varying circumstances. For various types see "firm-fixed price contract," "fixed-price contract providing for the redetermination of price," and "fixed-price-incentive contract." (Project 60)

Contract, prime – From DOD standpoint, any contract entered into directly by any military department or procuring activity of the Department of Defense. (Project 60)

Contractor – An individual or organization outside the Department of Defense which has accepted any type of agreement or order for providing supplies or services under procedures established by the Armed Services Procurement Regulation. The term specifically includes both a prime contractor and a subcontractor. (SECNAV 3900.24A)

Contractor, prime – A contractor who enters into a contract with an agency of the Government to produce, assemble, and deliver specific items of material or perform services in accordance with the requirements of the agency. (Project 60)

Corner-reflector antenna – An antenna consisting of a primary radiating element and a dihedral corner reflector.

Corona – A discharge of electricity appearing as a bluish-purple glow on the surface of and adjacent to a conductor when the voltage gradient exceeds a certain critical value. It is due to ionization of the surrounding air by the high voltage.

Corrective maintenance – Maintenance performed to restore an item to a satisfactory condition by correcting a malfunction that has degraded the item below the specified performance.

Corrosion, destructive – Any type of corrosion that in any way interferes with mechanical or electrical performance.

Cost/Effectiveness Analysis – A method of examining alternative means of accomplishing a military objective for the purpose of selecting weapons and forces that will provide the greatest military effectiveness for the cost.

Counterpoise – The ground (or reference) plane for an unbalanced antenna.

Coupling coefficient (coupling factor) – The coefficient of coupling (used only in the case of resistive, capacitive, self-inductance, and inductive coupling) is the ratio of the impedance of the coupling to the square root of the product of the impedances of similar elements in the two meshes. Unless otherwise specified, coefficient of coupling refers to inductive coupling, in which case it equals M/L_1L_2 where M is the mutual inductance, L_1 is the total inductance of one mesh, and L_2 the total inductance of the other mesh.

Criterion – Any basis for judging the appropriateness of a method, measuring device, formula, etc.; in learning studies, the arbitrary level of performance the subject must attain before ceasing practice.

Criticality – The effect of a malfunction of an item on the performance of a system.

Cross-Coupling – The coupling of a signal from one circuit to another where it becomes an undesired signal.

Cross modulation – 1. Cross modulation occurs if two signals, one of which is undesired, combine in a non-linear device. Under proper conditions, if an undesired signal enters a receiver along with the signal to which the receiver is tuned, the tuned frequency will be modulated by the undesired signal. This will then appear as an interfering signal in the receiver output. Differentiated from intermodulation interference in that one of the two signals is the desired signal.

2. Modulation of a desired signal by an undesired signal. This is a special case of intermodulation. MIL-STD-463.

Crosstalk – 1. Noise in a given channel originating in another channel of the same system.

2. Undesired power injected into a communication circuit from other communication circuits. May be intelligible or unintelligible.

3. An electromagnetic disturbance introduced by cross coupling. MIL-STD-463.

Crosstalk coupling – Crosstalk coupling between a disturbing and a distrubed circuit is the ratio of the power in the disturbing circuit to the induced power in the disturbed circuit observed at definite points of the circuits under specified terminal conditions.

Cryogenics – The technology of properties assumed by materials at temperatures approaching absolute zero. At these temperatures large current changes can be obtained by relatively small magnetic field changes.

Crystal filter – A filter in which at least one of the components is piezoelectrically resonant.

Cull model – An analytical process used to eliminate from further consideration, any equipment in a large-scale environment that can not possibly interfere with a particular receiver or receivers. (ECAC)

Cutoff frequency – Either of the frequencies bounding the transition region, usually the frequencies at which the attenuation is 3 dB.

Cybernetics – The comparative study of the control and intracommunication of information-handling machines and nervous systems of animals and man in order to understand and improve communication.

Damping – The decay in amplitude of electrical oscillation, mechanical vibrations, or sound waves caused by electrical, mechanical, or acoustical resistance. Tuned circuits are sometimes damped by the addition of external resistance in order to reduce the Q of the circuit, thereby increasing the bandwidth.

Data – A general term used to denote any or all facts, numbers, letters and symbols, or facts that refer to or describe an object, idea, condition, situation, or other factors. It connotes basic elements of information that can be processed or produced by a computer. Sometimes data is considered to be expressible only in numerical form, but information is not so limited.

Data base – ECAC data base – The data comprising the three categories of records maintained at ECAC, i.e., Electromagnetic Environmental Data, Communications-Electronic Equipment Characteristics Data, and Terrain Data. (ECAC)

Data Processing Equipment (DPE) – A general term for equipment designed especially for mass processing of data. It also includes transcription and transmission devices that are designed especially for producing media for mass data processing, such as punch cards, paper, or magnetic tapes. This term does not include office equipment used primarily for document creation, document posting, or individual computations such as typewriters, bookkeeping machines, adding machines, or desk size calculators (Project 60)

DB – $10 \log_{10} P_1/P_2$, where P_1 and P_2 are the powers being compared.

DBM – **dBm (dB referred to one milliwatt)** – The term is used in communication work as a measure of absolute power values. It is equal to $10 \log_{10} P$, where P is the power in milliwatts. Zero dBm equals one milliwatt.

Decade – A group or assembly of ten units; e.g., a counter that counts to ten in one column or a resistor box that inserts resistance quantities in multiples of powers of 10.

Decibel – A unit, one tenth of a Bel, used to indicate the ratio between two powers, voltages, currents, amplitudes, or signal levels. It cannot be used to indicate any absolute value without referring it to a base or zero level. The common zero power level is one milliwatt, and when so used, the unit is abbreviated as "dBm." The unit "dBuv" designates a common zero level of one microvolt. Plus dB's indicate a gain or level higher than the common zero level, minus dB's indicate a loss or a level lower than the common zero level. When the voltage gain of an amplifier is converted to dB using dB = $20 \log_{10}$ voltage ratio, the resulting dB will only be correctly used when the input and output impedances are the same. If input and output impedances are not the same, the dB gain can be found from the ratio of the input and output power levels. Sound intensity expressed in decibels is referred to a standard reference level of 0.0002 dynes per square centimeter, which is the average threshold intensity for a 1000 Hz tone. DB's equal $10 \log_{10}$ (power ratio) or $20 \log_{10}$ (voltage or current ratio). Easy factors to remember are a voltage gain of 2 = 6 dB, or a voltage gain of 10 = 20 dB and for a power ratio of 2 = 3 dB and a power ratio of 10 = 10 dB.

Defense Guidance Memorandum (DGM) – Documents covering problems other than major policy issues of interest to individual military services which require comprehensive analysis and planning. DGMs need not be force oriented.

Demodulation – The process of recovering the modulating wave from a modulated carrier.

Department of the Navy Five-Year Program (DNFYP) – The Navy's official programming document commonly referred to as the Blue Streak. This publication consists of eleven volumes or booklets and displays the Navy's portion of the Five-Year Defense Program (FYDP). SECDEF approved forces, manpower and financial data are given for each Navy Program Element for the current, budget and program years.

Desensitization – The reduction in sensitivity of a receiver due to the presence of an undesired signal.

Design Compatibility – EMC achieved by incorporation of engineering characteristics or features in all electromagnetic radiating and receiving equipments (including antennas) in order to eliminate or reject undesired signals, either self-generated or external, and enhance operating capabilities in the presence of natural or manmade electromagnetic noise.

Development, advanced – A category of RDT&E effort. Includes all projects which have moved into the development of hardware for experimental or operational test. It is characterized by line item projects, and program control is exercised on project basis. A further characteristic is that such items are designed as hardware for test or experimentation as opposed to items designed and engineered for eventual service use. (OPNAV 3900.8C)

Development concept paper (DCP) – Memorandum from SECDEF containing the recommendations for and record of decisions on the initiation of, or changes to, major R&D programs.

Deviation – A term used in frequency modulation to indicate the amount by which the carrier or resting frequency increases or decreases when modulated.

Deviation ratio – A term used in frequency modulation to indicate the ratio of the maximum amount of deviation of a fully modulated carrier to the highest audio frequency being transmitted.

Dielectric waveguide – A waveguide consisting of a dielectric structure.

Diffraction – The bending of a wave into the region behind an obstacle.

Diode – A device used to permit current flow in one direction in a circuit and to inhibit current flow in the other. In computers, these are primarily germanium or silicon crystals.

Dipole – A balanced linear antenna, split at its electrical center for connection to a transmission line. A tuned dipole antenna is approximately one half wavelength overall. The impedance of the tuned dipole antenna at its terminals is about 72 ohms. The radiation pattern is a maximum at right angles to the axis of the antenna. Also called a doublet antenna.

Dipole antenna – A straight radiator, usually fed in the center, producing a maximum of radiation in the plane normal to its axis. The length specified is the overall length.

NOTE. Common usage in microwave antennas considers a dipole to be a metal radiating structure that supports a line current distribution similar to that of a thin straight wire, a half wavelength long, so energized that the current has two nodes, one at each of the far ends.

Dipole reference – The power gain of an antenna, in a given direction, is the ratio (expressed in decibels) of the square of the field strength radiated in this direction by the given antenna to the square of the field strength radiated in its median plane by a perfect half-wave antenna isolated in space, where the fields are measured at a sufficient distance. It is assumed that the real antenna and the perfect half-wave antenna are supplied with equal power. Another common reference antenna is the isotropic antenna.

Direct bonds – Includes metal joints or interfaces formed by swaging, metal-to-metal joints held together by thread locking devices, riveted joints, tie rods, structural wires under heavy tension, pinned fittings driven tight and not subjected to wear, and clamped fittings normally permanent and immovable. It is normal practice to completely seal this joint at its edges after assembly with lacquer, paint, conductive paint, or sealers.

Direct wave – A wave that is propagated directly through space.

Directional coupler – A device used to extract a portion of the RF energy moving in a given direction in an RF transmission line. Energy moving in the opposite direction is rejected.

Directive – 1. A military communication in which a policy is established or a specific action is ordered.

2. A plan issued with a view to placing it in effect when so directed, or if a stated contingency arises.

3. Broadly speaking, any communication which initiates or governs action, conduct, or procedure. (Project 60)

Discone antenna – A broadband dipole consisting of a conical lower skirt and an upper short vertical section loaded with a capacitive disc.

Discriminator, FM – A device which converts variations in frequency to proportional variations in voltage or current.

Dish – Concave reflector antenna with circular periphery.

Distance Measuring Equipment (DME) – A radionavigation aid in the aeronautical radionavigation service that determines the distance of the interrogator from a transponder by measuring the time of transmission to and from the transponder.

Distortion – Distortion is said to exist when an output waveform is not a true reproduction of the input waveform. Distortion may consist of irregularities in amplitude, frequency, or phase.

Distortion, amplitude vs. frequency – Amplitude vs. frequency distortion of a transmission system is that distortion caused by the nonuniform attenuation, or gain, of the system, with respect to frequency, under specified terminal conditions.

Distortion, delay – That distortion caused by the difference between the maximum transit time and the minimum transit time of frequencies within a specified band.

Distortion, fortuitous – Distortion resulting from causes generally subject to random laws, for example, accidental irregularities in the operating of the apparatus and moving parts, disturbances affecting the transmission channel.

Distortion, phase – Phase (or time delay) distortion of a transmission system is that distortion caused by the fact that the transit time through the system is not the same for all frequencies, under specified terminal conditions.

Distortion, single harmonic – Single harmonic distortion is the ratio of the power at the fundamental frequency measured at the output of the transmission system considered, to the power of any single harmonic observed at the output of the system because of its non-linearity, when a single frequency signal of specified power is applied to the input of the system. It is expressed in dB.

Distortion, total harmonic – Total harmonic distortion is the ratio of the power at the fundamental frequency measured at the output of the transmission system considered, to the power of all harmonics observed at the output of the system because of its non-linearity, when a single frequency signal of specified power is applied to the input of the system. It is expressed in dB.

Distributed inductance – The inductance that exists along the entire length of a conductor, as distinguished from the self-inductance which is concentrated in a coil.

Ditch antenna – A flush antenna obtained by exciting a ditch or depression in ground or groundplane.

Diurnal – Pertaining to each day, daily, such as a diurnal cycle, a cyclic variation with a period of one day.

Diversity – The method of transmission or reception in which, to reduce the effects of fading, a single received information signal is derived or selected from several signals containing the same information. Improvement gained shall be expressed in dB.

Diversity, dual – The term applied to the simultaneous reception of two signals and their detection through the use of space, frequency, or polarization characteristics.

Diversity, frequency – Any method of transmission or reception wherein the same information signal is transmitted and received simultaneously on two or more distinct frequencies.

Diversity, quadruple – The simultaneous combining of four signals and their detection through the use of space, frequency, or polarization characteristics or combinations thereof.

Document – All types of formally recorded scientific and technical results from DOD research, development, test, and evaluation (SECNAV 3900.24A)

Doppler radar – Any form of radar which detects radial motion of a distant object relative to a radar apparatus by use of the Doppler effect.

Doppler shift – The change in frequency of a wave reaching an observer or a system, caused by a change in distance of range between the source and the observer or the system during the interval of reception.

Doppler system – A trajectory-measuring system using the Doppler frequency shift to obtain trajectory data.

Double-shield enclosure – A type of shielded enclosure in which the inner wall is partially isolated electrically from the outer wall.

Double sideband – In amplitude-modulated carriers, the intelligence is transmitted at frequencies both below and above the carrier frequency by the audio frequency value of the intelligence.

Downtime – That portion of calendar time during which the item is not in condition to perform its intended function.

Draft Presidential Memorandum (DPM) – A document issued by the Secretary of Defense that will discuss alternative strategies, forces, and resources. Three such documents will normally be prepared: General Purpose Forces, Strategic Forces, and Theater Nuclear Forces. (Interim Operating Procedures No. 1 of 21 June 1969.)

Duct – In microwave transmission, atmospheric conditions may cause radio waves to follow a narrower path than usual. The narrower path is called a duct. Ducting sometimes causes unusual transmission because the transmitted waves do not follow the intended path.

Dummy antenna – A device which has the necessary impedance characteristics of an antenna and the necessary power-handling capabilities, but which does not radiate or receive radio waves.

E

E Layer – One of the regular ionospheric layers with an average height of about 100 kilometers. This layer occurs during daylight hours, and its ionization is dependent on the sun's angle.

Earth/ground – The term applied to any conductor common to a number of circuits and which serves to maintain a constant potential, or to provide a bond of very small impedance, between the points of connection to it. In many cases, the earth itself is used as the conductor.

Echo – Echo is the effect of a wave which, having been derived, as by reflection, from a primary wave arrives at either end of the same circuit with sufficient magnitude and delay to be distinctly recognized.

Effective area – The square of the wavelength multiplied by the power gain (or directive gain) in that direction, and divided by 4π.

Effective height – (Present usage) The height of the antenna center of radiation above the effective ground level.

Effective program projections (EPP-FY) – The Department of Navy programs contained in the latest Five-Year Defense Program. Contains the current budget and the budgets of the ensuing four fiscal years. (BUWEPS 5200.25)

Electric field vector – At a point in an electric field, the force on a stationary positive charge per unit charge.

NOTE. This may be measured either in newtons per coulomb or in volts per meter. This term is sometimes called the electric field intensity, but such use of the word intensity is deprecated in favor of field strength, since intensity connotes power in optics and radiation.

Electrical – The term "electrical" is used in NAVAIRSYSCOM as an adjective to describe equipments and systems designed to use, generate, distribute, control, or measure power in AC or DC power systems. Examples of electrical equipments are mechanical and solid-state switching devices, meters, transformers, motors, generators, power tools, and ignition systems in automotive or other equipments.

Electrical equipment – Those equipments which do not produce any useful electrical signals internally. Equipments such as motors, fluorescent lamps, and light flashers fall into this class.

Electroexplosive device (EED) – Any ordnance device containing pyrotechnics, solid propellants, or explosives, or any combination of these, which can be actuated by electrical or electromagnetic energy.

Electromagnetic compatibility (EMC) –

1. Compatibility of electronic equipments or systems to be operated with a defined margin of safety in the intended operational environment at designed levels of efficiency without degradation due to interference. (MIL-STD-463).

2. EMC as applied to NAVAIRSYSCOM is defined as the capability of avionic and electrical systems, equipments, and devices to operate in their intended electromagnetic environment with a defined margin

of safety and at design levels of performance without unacceptable degradation as a result of electromagnetic interference. (NAVAIRSYSCOM)

3 The capability of electronic equipment or systems to be operated in the intended operational environment at designed levels of efficiency without degradation due to unintentional interference. (ECAC)

4. EMC is the ability of communications-electronics equipment, subsystems, and systems to operate in their intended operational environments without suffering or causing unacceptable degradation because of unintentional electromagnetic radiation or response. It does not involve a separate branch of engineering but directs attention to improvement of electrical and electronic engineering knowledge and techniques to include all aspects of electromagnetic effects.

Electromagnetic emission (EME) – Electromagnetic energy, desired or undesired, propagated from a source by radiation or conduction.

Electromagnetic environment – 1. The composite of electromagnetic energy, including man-made and natural sources, to which a system or subsystem or equipment will be exposed in performing its mission. When defined, the environment will be for a particular time and place.

2. The electronic equipments in a given geographical area and the radio frequency energy they radiate. (ECAC)

Electromagnetic field – Condition produced in space by the joint interaction of oscillating electric and magnetic forces which move independently of the charges or poles from which they originate. A varying electric field is always accompanied by a varying magnetic field; conversely a varying magnetic field is accompanied by a varying electric field. The resulting electromagnetic field represents a flow of energy in a direction at right angles to both the electric and magnetic components which are themselves at right angles to each other.

Electromagnetic interference (EMI) –

1. Electromagnetic interference is a condition in which an electromagnetic emission produces an undesired response in a specific susceptible component or subsystem.

2. As applied to NAVAIRSYSCOM, is defined as any emission (radiated or conducted) which degrades the specified performance of avionic equipments.

3. Any EM energy, radiated, inducted, or conducted, which degrades, obstructs, or interrupts the designed performance of electronic equipments.

4. Electromagnetic interference is the obstruction, interruption, or degradation of the desired performance characteristics of communications-electronic equipment resulting from excessive or undesired emissions. DoD Standardization Program FY 1969.

Electromagnetic propagation – The movement of electromagnetic energy (waves).

Electromagnetic susceptibility (EMS) – The tendency for an undesired response to be produced in a component by an electromagnetic emission.

Electronic countermeasures (ECM) – Any of various offensive or defensive tactics using electronic and reflecting devices to reduce the military effectiveness of enemy equipment or tactics using or affected by electromagnetic radiations.

Electronic equipment – 1. Those equipments such as radio receivers and signal generators that process useful electrical signals.

2 (AVIATION) – includes radar, identification and recognition (IFF), communications and navigation, radio, electronic countermeasures (ECM), sonar, sonobuoy, airborne receivers, magnetic detection (MAD), intercommunication systems, microphones, headsets, wire and tape recorders, airborne public address systems, antenna systems, antiprecipitation static systems, and special electronic equipments. (SD-24J General Spec for Design and Construction of Aircraft Weapon Systems)

Electronic equipment environment listing (EEEL) – An ECAC publication consisting of several printed volumes of selected data extracted from the equipment environment data file (E-File).

Electronic equipment environment survey (EEES) – The process of physically gathering environmental data using DD Form 1374. These forms are forwarded to operational units to be completed and returned to ECAC for processing. The processed data becomes part of the ECAC data base. (ECAC)

Electronic equipments, fixed – Electronic equipments whose antenna remains at a fixed geographic location or moves within an area not exceeding one half mile in diameter. (ECAC)

Electronic equipments, mobile – Electronic equipments, the locations of which are not fixed. (ECAC)

Electronics – A generic term to describe that branch of electrical science and technology concerned with the behavior of free electrons in vacuous or gaseous space and in semiconductors and the associated circuitry.

Electrostatic induction – The capacitive induction of interfering signal over an air gap separating an instrument, for example, from its wiring or housing.

Element, program – An integrated activity; an identifiable military capability; a force, support activity, or research activity comprising a combination of men, equipment, and facilities. (DOD 7045.1)

Elint – The field of electronic intelligence.

Elliptically polarized wave – An electromagnetic wave for which the electric and/or the magnetic field vector at a point describes an elipse. This term is usually applied to transverse waves.

Emission – Electromagnetic energy propagated from a source by radiation or conduction.

Emission spectrum – The power or electric field intensity versus frequency distribution of a signal about its fundamental frequency, which includes the fundamental frequency and the associated modulation sidebands as well as non-harmonic and harmonic spurious emissions and their associated sidebands.

Empirical propagation model – A propagation model that is based solely on measured path loss data. (ECAC)

Enclosure – A housing such as a console, cabinet, or case designed to protect and support mechanisms, electronic parts, and subassemblies.

Engineered performance standards (EPS) – Time in man/hours, expressed as standard time per unit of work, it would take an adequately trained individual or group to perform a defined task as determined by a trained technician using time study, rated random sampling, or predetermined standard time data systems. (DOD 5010.15)

Engineering change proposal (ECP) – A proposal submitted by the contractor to the procuring activity in accordance with contractual specifications, ANA Bulletin 390a, 391a, or 445, as applicable. The purpose of the ECP is to furnish information relative to a proposed engineering change to permit a preliminary evaluation of the change. Changes meriting further formal consideration are submitted to the IBCC Change Request (BUWEPs 5200.25)

Environment – The aggregate of external conditions and influences that surround and affect a system or vehicle. It includes natural phenomena such as temperature, pressure, solar radiation, or weather, and conditions introduced by the operation of the system or some action on it by an outside agent, such as nuclear radiation or explosive vapors.

Equipment – 1. All articles needed to outfit an individual or organization. (Dictionary of United States Military Terms for Joint Usage issued by the Joint Chiefs of Staff.)

2. A major functional part of a system or subsystem, usually consisting of several components, which is essential to operation of the system or subsystem; for example, a radio compass, altimeter, or electric power supply.

Equipment characteristics data base – All available data on equipment characteristics, including that which has been measured, synthesized, and extracted. (ECAC)

Equipment environment data base – That portion of the ECAC data base concerning electronic equipments and describing their geographic location, antenna orientation and position above terrain, how and when the equipment operates, frequency or frequencies used, PW and PRF combinations used, types of modulation. (ECAC)

Equipment environment data file (E-FILE) – That portion of the equipment environment data base which has been placed in the UNIVAC 1107 computer magnetic tape file. All records of the E-File are in the same format. (ECAC)

Equipment spectrum signature – An equipment spectrum signature is a summary and presentation of data showing all radio frequency energy radiations at a given location, both desired and undesired, of electronic equipments that generate electromagnetic energy for either internal or external use. It also includes the sensitivity characteristics of electronic equipment, including receivers, that are influenced by electromagnetic energy. The data is obtained by tests of radio frequency occupancy characteristics over the frequency range of 14 kHz to 10 GHz. These tests include radiations under normal operating and switching functions of transmit, receive, tuning, and band selection. Equipments intended for operation with antennas or radiating or receiving elements of more than one type shall have the transmission line or waveguide to the antenna, radiating or receiving element or elements terminated in a shield dummy load.

Erg — The unit of work equal to the work done by a force of one dyne acting through a distance of one centimeter.

Error voltage — A voltage present in a servo system when input and output shafts are not in correspondence. The error voltage, which actuates the servo system, is proportional to the angular displacement between the two shafts.

Estimate budget — An amount estimated for any element included in a budget. (Project 60)

Exploratory development goals (EDG) — Developed by the Chief of Naval Development, an EDG sets forth the technical basis for investigations, feasibility studies, experimental effort, and minor development required to advance technology in various functional areas. (OPNAV 3900.8C)

F

F layer — An ionized layer in the F-region of the ionosphere. Exists as a single layer, sometimes called F2 layer in the night hemisphere. Stratifies into F1 and F2 layers in the day hemisphere.

F1 layer — One of the regular ionospheric layers at an average height of about 225 kilometers, which occurs during the daylight hours and follows the sun closely.

F2 layer — The most useful ionospheric layer for radio wave propagation. It is the most highly ionized and highest of the layers, having an average night height of 225 kilometers and a mid-day height of about 300 kilometers. This layer is ionized throughout the day. Its ionization is least just before dawn and at maximum early in the afternoon.

Fading — Fading is the fluctuation in intensity of any or all components of a received radio signal due to changes in the characteristics of the propagation path.

Far-field region (Fraunhofer region) — That volume of space extending beyond the far-field distance. The far-field distance is that distance between two antennas equal to D^2/λ or 3λ, whichever is larger, where D is the maximum aperture dimension of the large antenna and λ is the wavelength at the fundamental frequency. (MIL-STD-463)

Fault correction time — That element of active repair time required under a specified maintenance philosophy to correct the malfunction. It may include correcting the malfunction with the faulty item in place, removing and replacing the item with a like serviceable item, or removing the item for corrective maintenance and reinstalling the same item.

Fault location time — That element of active repair time required for testing and analyzing an item to isolate a malfunction.

Femto — A prefix meaning multiplied by 10^{-15}.

Ferrod Antenna — A tapered rod of microwave ferromagnetic material fed by waveguide.

Fidelity — The degree of accuracy with which a system or portion of a system reproduces in its output the essential characteristics of the signal impressed on its input.

Field — A region in space influenced by a physical agency, such as electricity, magnetism, or gravitation, or any combination of them, produced by an electrically charged object, electrons in motion, a magnet, or a mass. Such fields are vector fields (electric, magnetic, or gravitational) or scalar fields (as a potential field).

Field strength (FS) – The intensity of radio frequency energy. The term "field strength" is applied only to measurements made in the far field. The measurement may be of either the electrical or the magnetic component of the field and may be expressed as V/m, A/m, or W/m^2; any one of these may be converted to the others. For measurements made in the near field, the term "electrical field strength" (EFS) or "magnetic field strength" (MFS) shall be used, according to whether the electric or magnetic field, respectively, is measured. The EFS shall be expressed as V/m, and the MFS as A/m. In this field region, the field measured will be the result of the radiation, induction, and quasi static ($1/r$, $1/r^2$, and, if present, $1/r^3$) components, respectively, of the field where r is the distance from the source. Since it is not generally feasible to determine the time and space phase relationships of the various components of this complex field, the energy in the field is similarly indeterminate. (MIL-STD-463)

Field strength meter – A measurement device used with antenna and receiver in making field strength measurements in RFI investigations.

Field tests – Measurements of radiated radio interference made upon a test item in open space (see definition below) with the test item operating under conditions simulating normal operation. Measurements of conducted interference made upon a test item at the actual site of installation of the item and with the test item operating under normal operating conditions shall be considered a field test of conducted interference.

Filter – A term widely applied to many kinds of device that permit selectively the passage through them of some kinds of matter or energy. Different respective classes of filter may be used to transmit selectively different types of radiation energy, nuclear particles, frequencies of electromagnetic or acoustic vibration, or to remove suspended particles from a fluid.

Filter (wave filter) – A transducer for separating waves on the basis of their frequency. It introduces relatively small loss to waves in one or more frequency bands and relatively large loss to waves of other frequencies.

Fireproof – A characteristic meaning that the material can withstand 2000° F. ±50° F. flame over approximately five square inches for fifteen minutes without penetration.

Fishbone antenna – An antenna consisting of a series of coplanar elements arranged in collinear pairs, loosely coupled to a balanced transmission line.

Five-year defense program (FYDP) – The official OSD publication that summarizes the approved plans and programs of the DOD components. (DOD 7045.7)

Fix – 1. A device or equipment modification to prevent interference or to reduce an equipment's susceptibility to interference. (ECAC)

2. The position or location of a radio transmitter as determined by radio direction finding.

3. In navigation, the determination of one's position by the use of radio navigational aids, and the position so determined.

Fix analysis – A study of effectiveness of a receiver's interference fixes on desired and undesired signals of various modulation types. (ECAC)

Fixed electronic equipment – Electronic equipment whose antenna remains at a fixed geographic location or moves within an area not exceeding one-half mile in diameter. (ECAC)

FM/AM – Amplitude modulation of a carrier by subcarriers that are frequency modulated by information.

FM/PM – Phase modulation of a carrier by subcarriers that are frequency modulated by information.

Folded dipole antenna – An antenna composed of two parallel, closely spaced dipole antennas connected at their ends, with one of the dipole antennas fed at its center.

Forces – Broadly, the fighting elements of the overall defense structure, units, equipment, etc., shown in the five-year defense program (FYDP).

Form, DD – A form used by two or more agencies or military departments of the Department of Defense – specifically: 1. A form prescribed by a Department of Defense agency under appropriate authority to be used by two or more military departments or agencies of the Department of Defense. 2. A form adopted for use by two or more military departments or by one or more military departments and one or more agencies of the Department of Defense (DOD 5000.8)

Fortran – A programming language designed for problems that can be expressed in algebraic notation, allowing for exponentiation and up to three subscripts. The Fortran compiler is a routine for a given machine which accepts a program written in Fortran source language and produces a machine language routine object program. Fortran II added considerably to the power of the original language by giving it the ability to define and use almost unlimited hierarchies of subroutines, all sharing a common storage region if desired. Later improvements have added the ability to use Boolean expressions, and some capabilities for inserting symbolic machine language sequences into a source program.

Franklin antenna – Base-fed vertical wire antenna several wavelengths high, and radiating broadside by the elimination of phase reversals by means of loading coils or wire folds.

Fraunhofer region – That region of the field in which the energy flow from the antenna proceeds essentially as though coming from a point source in the vicinity of the antenna. If the antenna has a well defined aperature D in a given aspect, the Fraunhofer region in that aspect is commonly taken to exist at distances greater than $2D^2/\lambda$, λ being the wavelength. In this region, the shape of the radiation pattern is relatively independent of distance from the antenna at which it is measured, and the electric and magnetic field components are substantially all transverse.

Free space – Usually refers to a condition where the radiation pattern of an antenna is not affected by surrounding objects such as earth, buildings, or trees.

Frequency allocation – 1. The establishing of radio frequency bands or designating radio frequencies for the performance of specific functions.

2. The frequency band or frequencies designated by allocation to perform a specific function. (ECAC)

Frequency, assigned – Usually the carrier frequency, actual or suppressed. For some services, a channel or band of frequencies may be assigned. Standards for operation establish limits of deviation from the assigned frequency.

Frequency assignment – 1. The command process of designating a radio frequency band, or more usually a radio frequency, to be used at a certain station under specified conditions of operation.

2. The frequency band or frequency designated by the act of assignment for use at a given station. (ECAC)

Frequency channel – The carrier plus allowed bandwidth limits of a frequency assignment. Example: 2716 6A3 is the Navy harbor frequency assignment (2716 kHz carrier, 6 kHz sideband limits, A3 modulation). Bandwidth is a critical part of a frequency channel.

Frequency coverage – That range (or those ranges) of frequencies over which a specific equipment is designed to operate; for example, the frequency coverage of the AN/URM-XX may be 0.15 to 0.4 MHz and 1.5 to 1000 MHz.

Frequency deviation – In frequency modulation, the peak difference between the instantaneous frequency of the modulated wave and the carrier frequency.

Frequency distortion – That form of distortion in which relative magnitude of the different frequency components of a complex wave are changed in transmission.

Frequency division multiplex – A process or device in which each signal channel modulates a separate subcarrier, the subcarriers being spaced in frequency to avoid overlapping of the subcarrier sidebands, and the selection and demodulation of each signal channel on the basis of its frequency.

Frequency engineering and management – The function whereby requirements for the use of the radio frequency spectrum are presented, reviewed, and satisfied initially and continually, and control of the spectrum is exercised. Frequency management consists of minimizing emission and reception bandwidths and controlling the character of emitted waves to prevent spurious and harmonic emissions.

Frequency, internal – A frequency intended for internal use within an equipment, such as that of a local oscillator, intermediate frequency amplifier, or frequency multiplier, and which is not intentionally coupled to the input or output terminals.

Frequency, lowest useful high (LUF) – The lowest high frequency effective at a specified time for ionospheric propagation of radio waves between two specified points.

Frequency, maximum usable (MUF) – The upper limits of the frequencies that can be used at a specified time for radio transmission between two points and involving propagation by reflection from the regular ionized layers of the ionosphere.

Frequency modulation (FM) – Angle modulation of a sine-wave carrier in which the instantaneous frequency of the modulated wave differs from the carrier frequency by an amount proportional to the instantaneous value of the modulating wave. Combinations of phase and frequency modulation are commonly referred to as "frequency modulation."

Frequency response – A measure of the ability of a device to take into account, follow, or act upon a rapidly varying input condition; for example, in an amplifier, the frequency at which the gain has fallen to one-half of the power gain factor, or to 0.707 of the voltage gain factor; in the case of a mechanical automatic controller, the maximum rate at which changes in the input condition can be followed and acted upon.

Frequency response characteristic – A variation with frequency of the transmission gain or loss of a device or system.

Frequency shift keying (FSK) – That form of frequency modulation in which the modulating wave shifts the output frequency between predetermined values, and the output wave has no phase discontinuity.

Frequency spectrum – Range of frequencies from low to high in terms of the number of vibrations or cycles in a unit of time.

Frequency tolerance – The allowable limits by which an emitter may deviate from a frequency assignment. Frequency tolerance below 100 MHz is usually .001 percent (100 Hz per MHz). Stations operating in a synchronous communications service (TTY, SSB) may require a closer tolerance with respect to each other than the allowed absolute deviation.

Fresnel region – The region between the antenna and the Fraunhofer region. If the antenna has a well defined aperature D in a given aspect, the Fresnel region in that aspect is commonly understood to extend a distance of $2D^2/\lambda$ in that aspect, λ being the wavelength. The near region is part of the Fresnel region.

Fresnel zones – Zones of wave reinforcement and destructive interference caused by interaction of direct waves and those waves reflected from the earth. (RCA - Point to Point Radio Relay Systems)

Front-to-rear ratio – The ratio of the effectiveness of a directional antenna toward the front and toward the rear.

G

Gain – The action by which the power of an electrical signal is increased, normally expressed in dB.

Gaussian noise – A noise whose power has a normal distribution.

General operational requirement (GOR) – GORs are broad statements of objectives and goals for operational capabilities needed to meet the estimated threat of the 5-15 year period. GORs guide the technical community in formulating new programs and in orienting current programs in research and exploratory development to advance particular areas of technology necessary to support the development of future warfare systems. The GOR is also an invitation to the producer to submit proposed technical approaches (PTAs) for achieving future needs when the necessary support technology is available.

Giga – A prefix denoting 10^9, abbreviated G.

Ground/earth – The term applied to any conductor common to a number of circuits and which serves to maintain a constant potential, or to provide a bond of very small impedance between the points of connection to it. In many cases the earth itself is used as the conductor.

Ground controlled approach (GCA) system – A ground radar system providing information by which aircraft approaches may be directed from the ground by radio telephony.

Ground plane – 1. A metal sheet or plate used as a common reference point for circuit returns and electrical or signal potentials.

2. (Aircraft) The ground plane is defined as the nearly equipotential plane created by interconnected (bonded) conducting surfaces or objects. (MIL-STD-463)

Ground-reflected wave – A radio wave that is reflected upward from the ground at a slight angle.

Ground wave – A radio wave that is propagated over the earth and ordinarily is affected by the presence of the ground. Ground waves include all components of waves over the earth except ionospheric and tropospheric waves. Ground waves are affected somewhat by the change in dielectric constant of the lower atmosphere.

Grounding – The process of physically providing a metallic surface with a low resistance or low impedance path to ground potential.

Grounding definitions – From Electromagnetic Control Requirements for Advanced ASW Avionics Systems BUWEPS 28 Feb. 1966.

1. Primary power ground – The ground referencing of primary AC and DC aircraft power. In the case of the P-3A aircraft, this would include power from the engine AC generators, battery, AC to DC converters (transformer rectifier), and the aircraft inverters.

2. Secondary power ground – The techniques used for ground referencing of power that is converted from primary aircraft power for use in and by a subsystem or black box. Examples of secondary power are transformer outputs used for filament power, B+ –B – supplies, etc.

3. Low-frequency signal ground – The grounding of electrical circuits that have low-level, low frequency susceptibility characteristics. Inputs of audio amplifiers, servo loops, error reference signals, and digital signals are examples of items that are grounded in accordance with low-frequency signal grounding rules. For the purpose of this document, low-frequency signals are defined as signals between 20 cps and 20 KC. RF signals will be defined as those above 100 KC. Signals with fundamental frequency in the 20 KC to 100 KC frequency range must be analyzed on an individual basis before assignment to one group or the other.

4. RF signal grounds – Refers to the grounding of RF circuits. Typical examples of RF circuits are local oscillators, receiver front ends, IF amplifier, and RF sections of transmitters.

5. Low frequency signal shield grounds – Refers to the ground referencing of shields covering a signal wire. Signal shields are normally made of nonferrous material such as copper or brass and provide protection against electric fields. Should the application require shielding of low frequency magnetic fields, ferrous material would be used. Grounding of the different types of material is covered under grounding rules.

6. RF signal shield ground – Refers to the grounding technique used for all shields used to prevent radiation from entering or leaving wires that carry or are subceptible to RF energy.

7. Chassis ground – Refers to the metal structure that supports the electrical components that make up the black box circuit. In practice, chassis ground is an extension of the airframe via metal-to-metal bonding; however, for the purpose of clarity, this document separates the chassis ground and airframe ground.

8. Airframe ground plane – Refers to all metallic items of the airframe that are bonded together. Airframe ground plane does not include the metal structure of boxes that contain electrical components and their mounting racks.

Grounding system – The total of all grounding techniques used in a given application.

Grounding system, floating – A grounding system using a completely isolated ground plane.

Grounding system, multiple-point – A grounding system in which the various components are grounded through short direct connections to the ground plane. In this system, many points on the ground plane should ideally be a unipotential device.

Grounding system, single-point – A system in which all ground connections are made to a single point on a ground plane.

Group – A collection of units, assemblies, or subassemblies which is a subdivision of a set or system, but which cannot perform a complete operational function. (Antenna group, indicator group.)

Guided propagation – The movement of electromagnetic waves through some environment where the energy is concentrated near a boundary, or between substantially parallel boundaries, separating materials of different properties, and whose direction is effectively parallel to these boundaries.

H

Half-power width of a radiation lobe – In a plane containing the direction of the maximum of the lobe, the full angle between the two directions in that plane about the maximum in which the radiation intensity is one-half the maximum value of the lobe.

Harmful interference – Any emission, radiation, or induction which endangers the functioning of a radionavigation service or of other safety devices, or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with (ITU) regulations. (ECAC)

Harmonic – A sinusoidal component of a periodic wave or quantity having a frequency which is an integral multiple of the fundamental frequency. For example, a component whose frequency is twice the fundamental frequency is called the second harmonic.

Harmonic distortion – Nonlinear distortion characterized by the appearance in the output of harmonics other than the fundamental component when the input is sinusoidal.

Heaviside layer – A layer of highly ionized air in the outer atmosphere which reflects certain high frequency radio waves. It reaches its maximum density about 70 miles above the earth's surface. Named for Sir Oliver Heaviside who predicted its existence. Also called Kennelly-Heaviside layer.

Helical scanning – A method of scanning in which the elemental area sweeps across the copy due to the motion of a helix. The most common form uses a combination of a single turn helix on a cylinder and a straight bar. The contact point between the bar and the helix traverses from one side to the other as the cylinder is rotated. The spiral on the cylinder is called the helix and the straight bar is called the helix bar.

HERO – "Hazards of electromagnetic radiation to ordnance."

Hertz – A unit of frequency equal to one cycle per second. Abbreviated Hz.

Hertz antenna – Elementary linear dipole radiator, with or without spherical or flat-plate ends (1887). Also loop antenna.

Heterodyne – To beat or mix two frequencies in a non-linear component so as to produce different frequencies.

Heterodyne frequency – A frequency which is produced by *combining* two other frequencies and which is their numerical sum or difference.

High-pass filter – A filter that attenuates all frequencies from zero to a specified cutoff frequency ("stop" band), and transmits all frequencies above that point ("pass" band).

Hollerith – A widely used system of encoding alphanumeric information onto cards, hence Hollerith cards are synonymous with punch cards. Such cards were first used in 1890 for the U.S. Census and were named after Herman Hollerith, their originator.

Horizontally polarized wave – A linearly polarized wave whose electric field vector is horizontal.

Human factors – Human psychological characteristics relative to complex systems, and the development and application of principles and procedures for accomplishing optimum man-machine integration and utilization. The term is used in a broad sense to cover all biomedical and psychosocial considerations pertaining to man in the system.

Hysteresis – 1. The lagging in the response of a unit of a system behind an increase or a decrease in the strength of a signal.

2 A phenomenom demon-

strated by materials which make their behavior a function of the history of the environment to which they have been subsubjected.

I

Image — One of two groups of sidebands generated in the process of modulation. Sometimes the unused group is referred to as the unwanted image.

Image frequency — In superheterodyne reception, an image frequency for any given point in the tuning range is that frequency which is higher or lower than the local-oscillator frequency by an amount equal to the intermediate frequency. Higher if the oscillator frequency is higher than the desired signal frequency; lower, in the opposite case.

Image response — The degree to which a superheterodyne receiver responds to an undesired signal at the image frequency while tuned to a desired signal.

Impedance — The impedance of an electric circuit to a current is the ratio of the applied rms voltage to the resulting rms current, provided there is no other source of power in the circuit. Impedance is the combination of the resistance and the reactance of the circuit, and equals the square root of the sum of the resistance squared and the reactance squared.

Impedance, characteristic — 1. The ratio of voltage to current at every point along a transmission line on which there are no standing waves.

2. The square root of the product of the open and short circuit impedance of the line. When a transmission line is terminated in its characteristic impedance, energy is not reflected, but is fully absorbed in the terminating impedance.

3. The observed input impedance of a properly terminated filter (ideally, substantially resistive and constant) at any passband frequency; pragmatically, the resistance value with which the filter must be terminated or from which it must be driven to ensure a specified performance.

Impedance matching — A method of minimizing the adverse effects of junctions between dissimilar transmission lines or connections between equipment with different impedances. To eliminate reflections from an impedance mismatch between elements A and B, the input impedance of B must equal the output impedance of A. To obtain maximum power transfer from A to B, B's impedance must be the same as A's. This means that if A is inductive, B must be equally capacitive, or vice versa. Various methods are used to make the impedance of dissimilar elements appear equal (a transformer for example), and the process is known as impedance matching.

Impedance transformer — Method of minimizing the adverse effects of junctions between dissimilar transmission lines, for instance, cable and open wire, whereby a transformer or auto transformer is used to interconnect the two, or loading coils are used to modify the impedance characteristic of a cable so as to match the open wire.

Impulse — An electromagnetic pulse of short duration relative to a cycle at the highest frequency being considered. Mathematically, it is a pulse of infinite amplitude, infinitesimal duration, and finite area. Its special energy distribution is proportional to its volt time area, and is uniformly and continuously distributed through the spectrum up to the highest frequency at which it may be considered an impulse. Regularly repeated impulses of uniform level will generate a uniform spectrum of discrete frequencies (Fourier components) separated in frequency by an amount equal to the repetition frequency. (MIL-STD-463)

Impulse bandwidth (IBW) — 1. The impulse bandwidth of a circuit in megahertz is the ratio of the rms sine-wave/level in microvolts, which produce a given peak response in the circuit, to the impulse spectral intensity in microvolts per megahertz required to produce an equal peak response.

2. The peak

value divided by the area of the impulse response envelope. (MIL-STD-463)

Impulse field sensitivity – That impulse spectral field intensity which will engender at the output of the measuring set a peak response 2 dB above that resulting from receiver output noise alone. The point of measurement and the impulse bandwidth to that point should be stated.

Units of measure:

Electric field intensity: dB uV/m/MHz

Magnetic field intensity: dB uA/m/MHz

NOTE. The manufacturer should furnish data relating the field intensity as a function of frequency to the interference measuring set input level or the antenna induced voltage, depending on whether shunt or series calibration, respectively, is used.

Impulse interference – Interference causing non-overlapping transient disturbances in a receiver.

Impulse noise – Noise characterized by transient distrubances separated in time by quiescent intervals. The frequency spectrum of these disturbances must be substantially uniform over the useful pass band of the transmission system.

Impulse sensitivity – That level of impulse spectral intensity input to an interference measuring set which will engender at its output a peak voltage response 2 dB above that resulting from the receiver noise alone. The point of output and the impulse bandwidth to that point should be stated.

NOTE. The peak meter is assumed to have an overall time constant long enough to obtain repeatable readings of the random noise, and to have a hold time or discharge time constant substantially longer than the longest expected period between impulses. The impulse bandwidth should be stated separately. Units of measure: dB uV/MHz.

Inactive time – The period of time when the item is available but is neither needed nor operating for its intended use.

In-band interference – Undesired signals being received on or near the frequency to which a receiver is tuned.

Incident wave – In a medium of certain propagation characteristics, a wave which impinges on a discontinuity or medium of different propagation characteristics.

Independent sideband transmission (twin sideband) – That method of communication in which the frequencies on the opposite sides of the carrier, produced by modulation, are not related to each other but are related separately to two sets of modulating signals. The carrier frequency may be transmitted suppressed or partially suppressed.

Indirect bonds – Any intermediate element used to electrically connect a component to the main structure ground plane.

Indirect wave – A high frequency radio wave reflected from one of the ionosphere layers in the outer atmosphere. Also called the sky-wave. See Heaviside layer.

Inductance – The property of an electrical circuit which tends to oppose a change of any current in the circuit. The symbol is "L" and the unit of measure is the "Henry."

Induction fields – Magnetic and electric fields which are predominant at distances that are short compared to wavelength.

Inductor – A device designed to have a specific inductance. It is usually made of a coil of wire, which may or may not be wound on an iron core. An inductor will pass direct current, but will have very high impedance to high-frequency alternating currents.

Information, classified – Official information which requires protection in the interest of national defense and which is classified for such purpose by appropriate classifying authority. Classified information of the Department of the Army, Navy, and Air Force in the hands of industry is to be considered and known as classified information of the Department of Defense, and shall be protected as provided for in the "Industrial Security Manual for Safeguarding Classified Information." (Project 60)

Information retrieval – The procedures used to identify, search, assemble, and recover specific information from stored data.

Information theory – A mathematical theory relating to the problems of the processing and transmission of information.

Input-output – A general term for the equipment used to communicate with a computer and the data involved in the communication. Synonymous with (I/O)

Insertion gain – The insertion gain of a transmission system (or component thereof) inserted between two impedances, Z_t (transmitter) and Z_r (receiver), is the ratio of the power measured at the receiver after insertion of the transmission system to the power measured before insertion, expressed in dB. If the resulting number in dB thus obtained is negative, an insertion loss is indicated.

Insertion loss – 1. At a given frequency, the insertion loss of a feed-through suppression capacitor or a filter connected into a given transmission system is defined as the ratio of voltages appearing across the line immediately beyond the point of insertion, before and after insertion. As measured herein, insertion loss is represented as the ratio of input voltage required to obtain constant output voltage, with and without the component, in the specified 50-ohm system. This ratio is expressed in decibels (dB) as follows:

$$\text{Insertion loss} = 20 \log \frac{E_1}{E_2}$$

Where:

E_1 = The output voltage of the signal generator with the component in the circuit.

E_2 = The output voltage of the signal generator with the component not in the circuit. (MIL-STD-220A)

2. The ratio, in dB, of the power in the load when the filter is out of the circuit, to the power in the load when the filter is in the circuit (with a constant source voltage).

3. The ratio of received powers before and after the insertion of shielding between a source and a receiver of electromagnetic energy.

Instrument landing system (ILS) – A system of radionavigation intended to assist aircraft in landing, which provides lateral and vertical guidance and indications of distance from the optimum point of landing.

Interface – 1. That boundary between two media especially as transited by a propagated wave, e.g., the inner surface of the bore of a gun.

2. The boundary, electrical or mechanical, existing between two systems or components (Project 60, quoted in RDT&E Management Guide)

Interference – 1. Any disturbance that causes undesirable response or malfunctioning of electronic equipments (BUSHIPS 5430.38).

2. Any undesirable electromagnetic emission (MIL-STD-463).

Interference mechanisms – Any process which may yield interference to a receiving device, such as desensitization, spurious response, and spurious emissions. (ECAC)

Intermediate frequency (IF) – The frequency in superheterodyne reception resulting from a frequency conversion before demodulation.

Intermodulation – Mixing of two or more signals in a nonlinear element, producing signals at frequencies equal to the sums and differences of integral multiples of the original signals. MIL-STD-463.

Intermodulation interference – Interference that occurs as the result of mixing two undesired signals in a non-linear element such as the first stage of a receiver or the final stage of a transmitter. The non-linear element may even be external to the communications equipment as in the case of a corroded metal-to-metal joint. This mixing may result in the generation of a new signal or signals of sufficient amplitude to be detected as interference.

International Telecommunication Union (ITU) – A civil international organization established to provide world-wide standardized communications procedures and practices including frequency allocation and radio regulations.

Interphone/intercom – A telephone apparatus by means of which personnel can talk to each other within an aircraft, tank, ship, or activity.

Intersystem interference – Interference between systems. A lack of system-to-system electromagnetic compatibility.

Intrasystem interference – Interference and resultant performance degradation confined within the physical and EM bounds of a single system.

Ionosphere – A region of electrically charged (ionized) air beginning about 25 miles above the surface of the earth, by means of which radio waves may be transmitted over great distances. It includes layers referred to as: (1) D layer, (2) E layer, (3) F1 layer, and (4) F2 layer. These layers vary in height and ionization with position of the sun. The air particles in the ionosphere are ionized by the ultraviolet rays from the sun and, perhaps to a less extent, by charged particles from the sun. This region of air is commonly referred to as the Heaviside Layer.

Ionosphere storms – Periods in which the ionosphere is disturbed from the normal condition. The virtual heights and the critical frequencies are abnormal, and during intense storms the ionosphere is diffused and expanded. Increased ionospheric absorption may be noted during very severe storms. These storms occur concurrently with magnetic storms and probably are caused by abnormal particle radiation from the sun.

Ionospheric disturbance – An ionospheric disturbance is a variation in the state of ionization of the ionosphere beyond the normally observed random day-to-day variation from average values for the location, date, and time of day under consideration.

I-S-M equipment – Federal Communications Commission designation for industrial, scientific, and medical equipment capable of causing interference.

Isotropic – A hypothetical antenna radiating or receiving equally in all directions; unipole antenna. Unipoles do not exist physically but represent convenient reference antennas for expressing directive properties of actual antennas.

Iterative – Describing a procedure or process which repeatedly executes a series of operations until some condition is satisfied. An iterative procedure can be implemented by a loop in a routine.

J

J antenna – Half-wave antenna, end fed by a parallel-wire quarter-wave section having the configuration of a J.

Jamming – The deliberate radiation, reradiation, or reflection of electromagnetic signals with the object of impairing the use of electronic devices by the enemy.

Janus antenna – Antenna with independent beams pointing fore and aft from a mobile craft.

Joint Intelligence Estimate for Planning (JIEP) – The JIEP provides a principal intelligence basis for the development of the JLRSS, JSOP, and JSCP. It is prepared by the Director, Defense Intelligence Agency and submitted to the Joint Chiefs of Staff for approval. (OPNAV 5000.19E)

Joint Long-Range Strategic Study (JLRSS) – The JLRSS provides the conceptual view of the Joint Chiefs of Staff concerning long-range use of U. S. military power and to provide broad strategic guidance for the development of military policies, plans, programs, and research and development objectives. The effective planning period is for 10 years after base date (always 1 July of current fiscal year). (OPNAV 5000.19E)

Joint Research and Development Objectives Document (JRDOD) – The JRDOD supports the JLRSS and JSOP by:

1. Translating broad strategic guidance concerning operational requirements into the research and development objectives considered essential to support the strategic concept.

2. Providing advice to the Secretary of Defense regarding the relative military importance of the research and development effort considered essential to support the strategic concept, the military objectives, and the needs of the commanders of unified and specified commands. (OPNAV 5000.19E)

Joint Strategic Capabilities Plan (JSCP) – Provides a statement of military strategy to support national policies and objectives based on capabilities and extends for one year (effective on 1 July of current FY). The JSCP constitutes a planning directive to commanders of unified and specified commands for the execution of military tasks assigned therein. (OPNAV 5000.19E)

Joint Strategic Objectives Plan (JSOP) – The JSOP provides the principal military advice of the Joint Chiefs of Staff to the Secretary of Defense for development of the DOD budget, and provides planning guidance to commanders of unified and specified commands and the services for the mid-range period. (OPNAV 5000.19E) The mid-range objective plan translates national objectives and policies into terms of military objectives, strategic concepts, and objective force levels. It focuses on the upcoming budget year and extends 8 years thereafter.

Joule – Unit of work or energy equal to 10^7 ergs.

K

Kelvin temperature scale (°K) – An absolute temperature scale independent of the thermometric properties of the working substance. On this scale the difference between two temperatures, T_1 and T_2, is proportional to the heat converted into mechanical work by a Carnot engine operating between the isothermic and adiabatic through T_1 and T_2. A gas thermometer using a perfect gas has the same temperature scale. For convenience, the Kelvin degree is considered identical to the Centigrade degree. The ice point is 273.16°K.

Kennelly-Heaviside Layer – A region of highly ionized air in the ionosphere, having maximum intensity at about 65 miles above the earth's surface, capable of reflecting or refracting radio waves back to earth under certain conditions. Also called Heaviside Layer or E Layer.

L

Laboratory tests – Measurements of radiated radio interference made upon a test item in the laboratory screen room or in a confined area of low ambient interference. Measurements of conducted interference performed under controlled conditions of ambient interference levels (at least 6 dB below the allowable specified interference limit), use of load or line impedance stabilization device, and operation of the test item under simulated normal operating conditions are considered laboratory tests of conducted interference. In the performance of laboratory tests of conducted interference, all requirements listed in the applicable specification or standard shall be complied with unless otherwise specified in the individual equipment specification.

Language – A system for representing and communicating information or data between people or between people and machines. Such a system consists of a carefully defined set of larger units, such as words or expressions, and rules for word arrangement or usage to achieve specific meanings.

Lead laboratory – A laboratory designated as the laboratory responsible for a lead area of effort based upon its skills and facilities. The assignment of a lead laboratory does not necessarily mean that the particular laboratory will do all the work in this assigned area. It does mean that all the work in the area will be fully monitored by the lead laboratory and that most of the effort will be assigned to that laboratory. (NAVSHIPS 250-331-1).

Leakage – The failure of a shield to attenuate RFI due to imperfection in design, engineering, construction, or maintenance. Usually most troublesome at access openings such as doors, power line openings, utility penetrations.

Level – This word, quite generally used as an abbreviation of "power level," is commonly expressed in decibles above or below a fixed reference level. In communications, 1 milliwatt is the most common reference level. If this reference level is used, the power is expressed as dBm, the last letter signifying 1 milliwatt.

Lightning protective zone – The lightning protective zone is the area under the apex of an imaginary 120-degree circular cone, or such space as is swept out by any hypothetical motion of such a cone normal to its axis, when either the apex or the ridge line developed by lateral motion thereof, is considered as a conductive discharge point or edge, which accordingly is directed at the lightning source and made suitably conductive to the cone base-or ground.

Limiter – A limiter is a device that holds nearly constant the amplitude of an electrical signal when it exceeds a specified value. The amount of reduction or compression increases with increase of the input amplitude.

Linearly polarized wave – At a point in a homogeneous, isotropic medium, a transverse electromagnetic wave whose electric field vector at all times lies along a fixed line.

Line item – 1. A complete descriptive entry on any document, including quantity, unit of issue, stock or part number, and description of the item involved.

2. A row of numerical facts in a tabular presentation. (Project 60)

Link – A general term used to indicate the existence of communication facilities between two points.

Lodge antenna – A counterpoise antenna consisting of a vertical dipole with horizontal top and bottom plates or screens, the lower spaced from ground. Other versions were the "bow-tie" antenna, where two narrow triangular plates were connected at their thin ends by a coil, and the "umbrella" antenna in which the end plates were made conical and constituted by wires (1897). Lodge also originated the waveguide open-end radiator and microwave lenses in 1894, before the spark microwave technology disappeared and was replaced by the longer wave techniques introduced by Marconi in 1896.

Logistic resources – The support personnel and materiel required to assure the mission performance of an item. It includes such things as tools, test equipment, spare parts facilities, and technical manuals, plus the administrative and supply procedures necessary to assure the availability of these resources.

Long-range objectives (LRO) – Basic guidance leading to the achievement of balanced long-range (ten to fifteen years hence) ship, aircraft, and weapons goals attainable under specific (self-imposed) fiscal assumptions. Based on the LRR, it is used solely for internal Navy guidance. (BUWEPS 5200.25)

Loop antenna – An antenna consisting of one or more complete turns of conductor and functioning by virtue of the circulatory current therein.

Lowest useful high frequency (LUF) – The lowest useful high frequency is the lowest frequency effective at a specified time for ionospheric propagation of radio waves between any two points, excluding frequencies below several megahertz.

Low-pass filter – A filter that transmits all frequencies from zero to a specified cutoff frequency and attenuates all frequencies above that point (complement of high-pass filter).

M

Magnetic circuit – The path of the flux as it travels from the north pole through the circuit components and back to the north pole. In a generator, the magnetic circuit components include the field yoke, field pole pieces, air gap, and armature core. The magnetic circuit may be compared to the electrical circuit, with magnetomotive force corresponding to voltage, flux lines to current, and reluctance to resistance. Thus, Ohm's law for the magnetic circuit may be expressed as $\phi = F/R$, where ϕ = number of flux lines expressed in maxwells, F = magnetomotive force expressed in gilberts, and R = reluctance of the circuit in cgs units.

Magnetic field – A state of the medium in which moving electrified bodies are subject to forces by virtue of both their electrifications and motion.

Magnetic storm – A disturbance in the earth's magnetic field, associated with abnormal solar activity and capable of seriously affecting both radio and wire transmission.

Maintainability – A characteristic of design and installation which is expressed as the probability that an item will conform to specified conditions within a given time when maintenance is performed in accordance with prescribed procedures and resources.

Maintainability characteristics – The qualitative and quantitative characteristics of material design and installation which make it possible to meet operational objectives with a minimum expenditure of maintenance effort (manpower, personnel skill, test equipment, technical data, and maintenance support facilities) under operational conditions in which scheduled and unscheduled maintenance will be performed.

Maintainability index – A quantitative figure of merit which relates the maintainability of an item to a standard reference.

Maintainability parameters – Maintainability parameters are quantitative measurements of requirements which must be achieved for the concerned article to meet its operational requirements. Examples of such parameters are: (1) Maintenance manhours per flight hour, (2) turn-around time required for returning the article to an operationally-ready condition, (3) percentage of articles which can be down for maintenance and still permit the attainment of the operational requirement.

Maintenance – All actions necessary for retaining an item in, or restoring it to, a serviceable condition. Maintenance includes servicing, repair, modification, modernization, overhaul, inspection, and condition determination.

Maintenance, depot – That maintenance performed on material requiring major overhaul or a complete rebuild of parts, assemblies, subassemblies and end items including the manufacture of parts, modifications, testing, and reclamation as required. Depot maintenance serves to support lower categories of maintenance by providing technical assistance and performing that maintenance beyond their responsibility. It provides stocks of serviceable equipment by using more extensive facilities for repair than lower level maintenance activities. JCS PUB-1, NAVAIR INST 4700.2

Maintenance, intermediate – That maintenance which is the responsibility of and performed by designated maintenance activities for direct support of using organizations. Its phases normally consist of calibration, repair, or replacement of damaged or unserviceable parts, components or assemblies; the emergency manufacture of nonavailable parts; and provision of technical assistance to using organizations. JCS PUB-1, NAVAIR INST 4700.2

Maintenance, organizational – That maintenance which is the responsibility of and performed by a using organization on its assigned equipment. Its phases normally consist of inspecting, servicing, lubricating, adjusting, and replacing parts, minor assemblies, and subassemblies. JCS PUB-1, NAVAIRINST 4700.2

Maintenance requirements cards (MRC) – Sets of cards issued by BUWEPS containing scheduled maintenance requirements applicable to intermediate and organizational level activities for the specific aircraft model for which the cards are issued. NAVAIRINST 4700.2

Major force issued (MFI) – Issues concerning proposals which, if approved, would have a major quantitative or qualitative effect on military forces. (OPNAV 5000.19E)

Major milestones – Dates planned for accomplishing major actions such as design, test phase, evaluation phase, verification phase, MEAR and publication completion dates, MEAR and publication revision dates, and Integrated Maintenance Management Team Conference dates.

Malfunction – A failure of a system or associated subsystem/equipment due to electromagnetic interference or susceptibility that results in a threat to flight safety, a mission abort, or failure to accomplish mission.

Management, project – A concept for the business and technical management of selected projects based on the use of a designated, centralized management authority who is responsible for planning, directing, and controlling the definition, development acquisition, initial logistic support of weapon systems and execution of project objectives; and for the integration and coordination of planning the scheduled accomplishment by the organizations responsible for the complementary functions of follow-on logistic and maintenance support, preparation of personnel training plans, and preparation for operational testing, in accordance with the project charter or official joint agreements with other military departments or other

Government agencies and the Project Master Plan. (Activation and deployment of operating elements is a responsibility of the Chief of Naval Operations.) The centralized management authority is supported by functional organizations, which are responsible for the execution of project tasks assigned. (NAVMAT 5000.5A)

Management system – The direction, evaluation, and control of a specific weapon or equipment/space system from the decision to develop, through the procurement and production phase, to distribution to final destination including "feed-back" from users concerning operational effectiveness. System management also includes the interrelated processes of programming, organizing, coordinating, and evaluating the efforts of subordinate commands and organizations to accomplish systems management objectives. (Project 60)

Marconi antenna – The original name of vertical wire antenna, base fed with a ground connection. (1896)

Matrix – 1. An array of quantities in a prescribed form; in mathematics, usually capable of being subject to a mathematical operation by means of an operator or another matrix according to prescribed rules.

2. An array of coupled circuit elements; e.g., diodes, wires, magnetic cores, and the conversion from one numerical system to another. The elements are usually arranged in rows and columns. Thus a matrix is a particular type of encoder or decoder.

Measured spectrum signature data – The spectrum signature information of a given electronic equipment obtained by direct measurement using specific measuring instruments operated in a standard fashion (MIL-STD-449). (ECAC)

Message – Any thought or idea expressed briefly in plain or secret language, prepared for transmission by any means of communication.

Method, Monte Carlo – A trial and error method of repeated calculations to discover the best solution to a problem. Often used when a great number of variables are present, with interrelationships so complex as to forestall straightforward analytical handling.

Micro – A prefix denoting 10^{-6}

Microvolts per megahertz – The broadband emission intensity in rms sine wave microvolts (unmodulated), applied to the input of the measuring circuit at its center frequency, which will result in peak response in the circuit equal to that resulting from the broadband pulse being measured, divided by the effective impulse bandwidth of the circuit in megahertz.

Mid-range objective (MRO) – MRO serves the dual purpose of deriving quantitative force structure goals and of advancing new concepts and technology by providing guidance for updating operational requirements and advanced development objectives. MRO is further quantitative basis for research and development leading to the annual updating of general operational requirements (GOR) (OPNAV 5000.19E)

Milestones – Recognizable points in time at which specific tasks or activities (major or minor) start or end. (BUWEPS 5200.25)

Military improvement plan (MIP) – An annual compilation that establishes a priority order for, and implements and controls in an orderly manner, the accomplishment of and budgeting for alterations selected from items contained in class improvement plans for active ships (OPNAV 4720.2A)

Military inter-departmental purchase request (MIPR) – A procurement order issued by one military service for another military service to procure, produce, or deliver services, supplies, or equipment to or for the ordering service. (Project 60)

Milli – A prefix denoting 10^{-3}

Minimum discernible signal (MDS) – The minimum input pulse signal power level which permits visibility of any portion of the output signal on oscilloscope type indicators. This level is obtained by initially setting the input signal above the detection threshold and then slowly decreasing the amplitude.

Mission – The objective; the task, together with the purpose; which clearly indicates the action to be taken and the reasons for it.

Mission time – The period of time in which an item must perform a specified mission.

Mistake – A human failing such as faulty arithmetic, use of an incorrect formula, or incorrect instructions. Mistakes are sometimes called gross errors to distinguish from rounding and truncation errors. Thus, computers malfunction and human beings make mistakes. Computers do not make mistakes; human beings do not malfunction, in the strict sense of the word.

Mode of transmission – A form of propagation of guided waves that is characterized by a particular field pattern in a plane transverse to the direction of propagation, in which field pattern is independent of position along the axis of the waveguide.

Model, mathematical – 1. The general characterization of a process, object, or concept in terms of mathematics, which enables the relatively simple manipulation of variables in order to determine how the process, object, or concept would behave in different situations.

2. An analytical tool based on theoretical equations and procedures. (ECEC)

Modification, contract – Any written alteration in the specification, delivery point, rate of delivery, or other contract provisions of an existing contract, whether accomplished by unilateral action in accordance with a contract provision, or by mutual action of the parties to the contract. It includes bilateral actions such as supplemental agreements and amendments, and unilateral actions such as change orders, notices of termination, and notices of the exercises of a contract option. (Project 60)

Modulated CW field sensitivity – That CW field intensity, modulated 30 percent at 400 Hz, which will produce at a point subsequent to the IF detector, a 400 Hz/noise power ratio of unity. The point of measurement and the noise bandwidth to that point should be stated.

Units of measure:

a. Electric field intensity: dB uV/m

b. Magnetic field intensity: dB u/Am

NOTE. The manufacturer should furnish data relating the field intensity as a function of frequency to the interference measuring set input level or the antenna induced voltage, depending on whether shunt or series calibration, respectively, is used.

Modulated CW sensitivity – That CW power input to an interference measuring set, modulated 30 percent at 400 Hz, which will produce at a point subsequent to the IF detector, a 400-Hz/noise power ratio of unity. The point of measurement and the noise bandwidth to that point should be stated.

Unit of measure: dBm.

Modulation -- Modulation is the process of varying some characteristics of the carrier wave in accordance with the instantaneous value or samples of the intelligence to be transmitted.

Modulation, amplitude – Amplitude modulation is the form of modulation in which only the amplitude of the carrier is varied in accordance with the instantaneous value of the modulating signal.

Modulation, frequency – Frequency modulation is modulation in which the instantaneous frequency of a sine wave carrier is caused to depart from the carrier frequency by an amount proportional to the instantaneous value of the modulating wave, with relatively no change in the amplitude of the carrier.

Modulation index – In angle modulation with a sinusoidal modulating wave, the ratio of the frequency deviation to the frequency of the modulating wave.

$$m = \frac{\Delta f}{f_{max}}$$

where Δf is the maximum frequency difference between the modulated carrier and the unmodulated carrier and f_{max} is the maximum modulation frequency.

Modulation, phase – Phase modulation is the form of modulation in which only the angle relative to one unmodulated carrier angle is varied in accordance with the instantaneous value of the amplitude of the modulating signal. This produces a radio frequency spectrum almost identical to that produced by frequency modulation.

Modulation, pulse amplitude – Pulse amplitude is the form of modulation in which the amplitude of the pulse carrier is varied in accordance with successive samples of the modulating signal.

Modulation, pulse frequency – Pulse frequency modulation if the form of modulation in which the pulse repetition frequency of the carrier is varied in accordance with successive samples of the modulating signal.

Modulation (radio) – The process of producing a wave, some characteristic of which varies as a function of the instantaneous value of another wave, called the modulating wave.

Modulator – A device for placing an intelligence signal on a carrier wave.

Modulator, balanced – In electronics, a circuit arrangement in which a carrier frequency is controlled by a signal wave in a manner to generate the sideband frequencies but suppress the carrier in the output.

Module – 1. A packaged assembly of wired components built in a standardized size and having standardized plug-in or solderable terminations. It may or may not include an amplifying element such as a tube or transistor. Used in combination with other modules to form a complete electronic system.

2. A pre-packaged assembly of functionally associated electronic parts, usually a plug-in unit, arranged to function as a system or subsystem; a black box.

Moving target indication (MTI) – An electronic technique by which only targets in motion are normally shown on a display.

Multiconductor waveguide – A waveguide consisting of two or more conductors (commonly called transmission lines).

Multipath transmission – The propagation phenomenon which results in signals reaching the radio receiving antenna by two or more paths, usually having both amplitude and phase differences between each path.

Multiplex – Denotes the simultaneous transmission of several functions over one link without loss of detail of each function, such as amplitude, frequency, phase, or wave shape. Very high-speed commutation that would satisfy these conditions could, in special instances, be correctly classified as multiplexing. However, to prevent confusion, the term "commutation" is still to be preferred whenever a switch is used.

Multiplexer – A device by which two or more signals may be simultaneously transmitted using the same common carrier wave.

Mutual interference chart (MIC) – A plot or matrix with ordinate and abscissa representing the tuned frequencies of a single transmitter-receiver combination, which indicates potential interference to normal receiver operation by reason of interaction of the two equipments under consideration at any combination of tuned transmit/receive frequencies. This interaction includes transmitter harmonics and other spurious emissions, and receiver spurious responses and images. (ECAC)

N

Nano – A prefix denoting 10^{-9}.

Nanosecond – One thousandth of a millionth of a second, 10^{-9} seconds. Synonymous with millimicrosecond.

Narrowband emission – That which has its principal spectral energy lying within the bandpass of the measuring receiver in use. (MIL-STD-463)

Narrowband interference – Narrowband interference comprises CW signals, modulated or unmodulated, such as a carrier frequency, or signals whose energy is distributed over a spectrum of frequencies that is narrow when compared with the bandwidth of the receiver or interference-measuring equipment.

Naval Research Advisory Committee (NRAC) – The NRAC is a committee of private civilians that reports to the Secretary of the Navy. They advise the Secretary of the Navy, the Chief of Naval Operations, and the Chief of Naval Research on all research matters. (NAVSHIPS 250-331-1)

Naval research requirements (NRR) – An NRR is a statement in general terms of the need for investigations and studies in the physical and life sciences to provide information related to a solution of specific practical problems and to obtain a fuller knowledge or understanding of the subject under study. Naval research requirements are published by CNR and constitute a directive to all developing agencies to plan for and initiate appropriate projects in their areas of competency. (OPNAV 3900.8B)

Navy automated research & development information system (NARDIS) – A system for storing and retrieving R&D information. Operation of NARDIS is under the direction of the Commanding Officer and Director of the David Taylor Model Basin. Technical responsibility is under CNR. The DD Form 1498 plus the NARDIS supplement are used as inputs to the system. Output takes two forms, logistic and subject matter. (ONR 3900.23)

Navy capabilities plan (NCP) – The NCP provides a basis for the Navy position in staffing the JSCP for the current fiscal year. It provides direction and guidance for the functions, administration, and support of Navy forces, and concepts for their mobilization, organization, training, and equipping. (OPNAV 5000.19E)

Navy industrial fund (NIF) – A fund under which industrial activities are provided with working capital. Replenished through periodic billings to its customer activities for which work is performed. (BUWEPS 5200.25)

Navy logistic capabilities plan (NLCP) – Issued as an annex to the NCP and contains the logistic implications for the naval establishment in support of the guidance contained in the JSCP. (OPNAV 5000.19E)

Navy objectives plan (NOP) – Covers the strategic concepts and objectives of the Navy during the next 10 years. These concepts and objectives are to be in agreement with Joint Chiefs of Staff plans and Navy estimates for active and reserve forces considered necessary to engage in cold, limited, and general war under various conditions, including the provisions for full mobilization needs. It will include, separately identified, the approved Navy forces plus the incremental additional forces which the Chief of Naval Operations considers essential to carry out the military tasks and functions assigned to the Navy in the Joint Chiefs of Staff Plans and other authoritative strategic plans and sources. (OPNAV 5000.19E)

Navy strategic study (NSS) – Provides concepts and philosophy concerning future naval contributions to national defense and basic guidance for Navy long-range and mid-range planning. It appraises the world situation for these periods, outlines the potential threats and the national and military policy, objectives, and strategy. It summarizes the Navy's roles and tasks and provides a scientific and technological forecast. The NSS, with annexes described below, is issued annually on 1 January, covering the period five to twenty years in the future from the end of the current fiscal year.

1. Annex A to NSS-Navy mid-range guidance (NMRG) – projects qualitative force and research and development guidance for a five year period commencing 1 July, five years after the end of the fiscal year in which approved. It provides a basis for the development of research and development goals, and with the basic document, provides a basis for the Navy input to the JSOP strategy and mid-range strategic guidance used in the development of MRO.

2. Annex B to NSS-Navy long-range guidance NLRG – provides long-range research and development guidance for a ten year period commencing 1 July, ten years after the end of the fiscal period in which approved. It is the primary basis for the Navy input to the JLRSS and JRDOD, provides a broad frame of reference for mid-range planning and, with the basic documents, provides long-range strategic guidance used in the development of the MRO (mid-range objectives). (OPNAV 5000.19E)

Near-field region – The immediate neighborhood of the antenna where the energy distribution is poorly defined and where no approximation can be made which is significant in terms of the far-field radiation pattern.

Necessary bandwidth – For a given class of emission, the necessary bandwidth is the minimum value of the occupied bandwidth sufficient to ensure the transmission or reception of intelligence at the rate and with the quality required for the system used, under specified conditions. Emissions useful for effective functioning of the receiver equipment, as, for example, the emission corresponding to the carrier of reduced carrier systems, shall be included in the necessary bandwidth.

Net – An organization of stations capable of direct communications on a common channel/frequency.

Noise – 1. Any undesired sound. By extension, noise is any unwanted disturbance within a useful frequency band, such as undesired electric waves in a transmission channel or device. When caused by natural electrical discharges in the atmosphere, noise may be called static.

2. An erratic, intermittent, or statistically random oscillation.

3. In electrical circuit analysis, that portion of the unwanted signal which is

statistically random, as distinguished from hum, which is an unwanted signal occuring at multiples of the power supply system frequency.

NOTE. If the nature of the noise is ambiguous, a phrase such as acoustic noise or electric noise should be used. Since the above definitions are not mutually exclusive, it is usually necessary to depend on context for the distinction.

Noise bandwidth – The noise bandwidth of a network is the area divided by the height, at the center-tuned frequency, of the power-gain-vs-frequency characteristic. It is generally considered as the 3-dB-down bandwidth of the desired response.

Noise figure – A figure of merit which expresses the ratio of noise in a given receiver to that in a theoretically perfect receiver. Noise figure is the ratio of the total noise per unit bandwidth at the output of the system to the portion of the noise power that is due to the input termination at the standard noise temperature of 290°. Also called noise factor.

Noise level – Noise level is the value of noise integrated over a specified frequency range with a specified frequency weighting and integration time. It is expressed in decibels relative to a specified reference.

Noise temperature (standard) – The standard reference temperature T_o for noise measurements is taken as 290°K.

NOTE. $KT_o/e = 0.0250$ volt where e is the electron charge and K is Boltzmann's constant.

Noise, thermal – The basic limitation on the sensitivity of any electrical signal receiving or measuring device is the random electrical noise generated within the device itself. The noise is produced by the thermal agitation of charge carriers in resistors, resistive impedances, semiconductors and gaseous discharges, and by the electron stream in vacuum tubes. This electrical noise is amplified along with the signal being measured, and appears in the output, where it masks the signal and interferes with its use or measurement to a degree dependent upon the ratio of noise to signal. The definition of noise figure is based upon the measurement of this noise and its ratio to that which would exist if the instrument added none to that entering from the signal source.

Nominal characteristics file (NCF) – Magnetic tape record containing the nominal equipment characteristics of transmitters, receivers, and antennas of radar and communications equipment in a specified format, along with pertinent physical information. (ECAC)

Nominal equipment characteristics – The nominal values of the electrical and physical parameters of a given electronic equipment which affect the generation or reception of electromagnetic energy. These data are usually obtained from the manufacturer's equipment manual and are used in synthesized spectrum signatures. (ECAC)

Normalize – 1. In programming, to adjust the exponent and fraction of a floating point quantity so that the fraction lies in the prescribed normal standard range.

2. In mathematical operations, to reduce a set of symbols or numbers to a normal or standard form. Synonymous with standardize.

Notation – 1. The act, process, or method of representing facts or quantities by a system or set of marks, signs, figures, or characters.

2. A system of such symbols or abbreviations used to express technical facts or quantities; as mathematical notation.

3. An annotation; note

Nupac monitoring set – A warning system that detects undesirable radiation emanating from a nuclear reactor and associated equipment. It may include such units as radiac computers, radiac indicators, radiac detectors, amplifiers, and warning devices.

O

Objective – The goal of a requirement which is reasonably feasible of attainment within the expected availability of the resources of men, money, and technological capability.

Obligation, formal – A Navy term for actual obligation evidenced by a formal document individually recorded on records of cognizant bureau. Formal obligations include contracts and purchase orders, letters of intent, and project orders. (Project 60)

Octal – Pertaining to eight; usually describing a number system of base or radix eight; e.g., in octal notation, octal 214 is 2 times 64, plus 1 times 8, plus 4 times 1, and equals decimal 140. Octal 214 in binary-coded-octal is represented as 010,001,100; octal 214, as a straight binary number is written 10001100. Note that binary coded octal and straight binary differ only in the use of commas; in the example shown, the initial zero in the straight binary is dropped.

Ohm – Unit of electrical resistance equal to the resistance of a circuit in which a potential difference of one volt produces a current of one ampere.

Open area - A site for radiated electromagnetic interference measurements which is open flat terrain far enough from buildings, electric lines, fences, trees, underground cables, and pipe lines so that their effects are negligible. This site should have a sufficiently low level of ambient interference to permit testing to the required limits. (MIL-STD-463)

Operational – Operational is the time at which field use may be expected, assuming normal production and training periods that reflect the priority of the project. (NAVSHIPS 250-331-1)

Operational compatibility – Refers to EMC achieved by the application of C-E equipment flexibility to ensure interference-free operation in homogeneous or heterogeneous environments of C-E equipments. It involves the application of sound frequency management and clear concepts and doctrines to maximize operational effectiveness. It relies heavily on initial achievement of design compatibility.

Operational maintenance – Maintenance that is performed without interrupting the satisfactory operation of the item.

Operational Test and Evaluation Force (OPTEVFOR) – The OPTEVFOR is an operational fleet command under the administrative command of Commander-in-Chief, U.S. Atlantic Fleet, ComOPTEVFOR shall have primary responsibilities to the Chief of Naval Operations in the areas of test and evaluation in support of the Navy's RDT&E program. (NAVSHIPS 250-331-1)

Order – 1. A defined successive arrangement of elements or events. This term is losing favor as a synonym for instructions, due to ambiguity.

2. To sequence or arrange in a series

3. The weight or significance assigned to a digit position in a number.

Order, change – A written order signed by the contracting officer directing the contractor to make changes which the changes clause of a contract authorizes the contracting officer to order without the consent of the contractor. (Project 60)

Over-all system performance – The range capability of a radio system. Over-all system performance depends upon three factors: (1) the transmitted power, (2) the loss in the propagating medium, and (3) the minimum discernible received signal.

P

Pad – 1. A nonadjustable attenuator.

2. A resistance network used in coupling two impedances.

PAM-FM – A system in which several pulse amplitude modulated subcarriers are used to frequency modulate a carrier.

Parabola; paraboloid – Bowl-shaped reflector for radar or microwave radio antennas.

Parallel resonance – A condition at a particular frequency in a circuit containing an inductance in parallel with a capacitance in which the inductive reactance is equal in magnitude and opposite in polarity to the capacitive reactance. The circuit impedance is maximum, and the output current is at a minimum.

Parameter – 1. A quantity in a subroutine whose value specifies or partly specifies the process to be performed. It may be given different values when the subroutine is used in different main routines or in different parts of one main routine, but usually remains unchanged throughout any one such use.

2. A quantity used in a generator to specify machine configuration, designate subroutines to be included, or to otherwise describe the desired routine to be generated.

3. A constant or a variable in mathematics that remains constant during some calculation.

4. A definable characteristic of an item, device, or system.

Parameter sensitivity – Effect of the variation of individual input parameters on an analytical output. (ECAC)

Parasitic oscillations – Oscillations produced by the distributed capacities and distributed inductances in circuits; especially such oscillations in frequencies above audibility, which add to the load on amplifying tubes without producing useful sound output.

Part – One piece, or two or more joined pieces which are not normally subject to disassembly without destruction of designed use. (Examples: Outer front wheel bearing of 3/4-ton truck, electron tube, composition resistor, screw, gear, mica capacitor, audio transformer, milling cutter.)

Passband – A range or band of frequencies transmitted by a filter without significant attenuation.

Passive filter – A filter in which none of t' components in the network are active, i.e., incorporating no energy-contributing or amplifying elements.

Path attenuation – The power loss between transmitter and receiver due to all causes. It is equal to 10 $\log_{10} P_t/P_r$ where P_t is the power radiated from the transmitting antenna and P_r is the power available at the output terminals of the receiving antenna and is expressed in decibels.

PDM/PM – Phase modulation of a carrier by pulses which are duration modulated by information.

Performance degradation – The reduction in performance of an equipment or system due to interference. (ECAC)

Peripheral components – Those devices needed to complete or complement the primary function of the overall antenna or waveguide system.

Permeability – Of a magnetic material, the ratio of the magnetic induction to the magnetic field intensity in the same region.

PERT – A set of principles, methods, and techniques for effective planning of objective-oriented work, which establishes a sound basis for effective scheduling, controlling, and replanning in the management of programs. It employs: • A product-oriented work breakdown structure, beginning with these objectives subdivided into successively smaller items. • A flow plan consisting of all the activities and events that must be completed or accomplished to reach the program objectives, showing their planned sequence, interdependencies, and interrelationships. This is called a network. •Elapsed time estimates and identification of critical paths in the networks. • A schedule that attempts to balance the objectives, the network flow plan, and resources availability. •Analysis of the interrelated networks, schedules, and slack values as a basis for continuous evaluation of program status, forecast of overruns, and the identification of problem areas in time for management to take corrective action. (Pert Guide for Management Use)

Phase – 1. Relation, measured angularly, between current and voltage in alternating current, or between currents or between voltages.

2. Number of separate voltage waves in a commercial alternating current supply as "single phase" and "three phase"; abbreviated by the Greek letter phi (ϕ).

3. The angular difference between two sine waves of the same frequency, equal to the product of the angular frequency and the time interval between the instants at which the amplitude of each wave is zero.

Phase (delay) distortion – Impairment of fidelity as a result of nonlinear phase characteristics, which cause various frequencies of an applied waveform to be delayed disproportionately.

Phase modulation (PM) – Angle modulation in which the angle of a sine-wave carrier is caused to depart from the carrier angle by an amount proportional to the instantaneous value of the modulating wave.

NOTE. Combinations of phase and frequency modulation are commonly referred to as "frequency modulation."

Phase velocity – Of a traveling plane wave at a single frequency, the velocity of an equiphase surface along the wave normal.

Physical parameter – A quantity, usually constant, for a given set of conditions to which arbitrary values are assigned that aid in describing and characterizing physical devices.

Pico – A prefix denoting 10^{-12}.

Piezoelectric - A term applied to the phenomenon whereby certain materials, commonly crystalline, develop useful electrical pressures (voltages) when the material is subjected to variable mechanical pressures, strains, or stresses: conversely, the materials develop mechanical strains or stresses when electrical voltages are applied.

Piezoelectric resonance – Resonance (i.e., bipolar slope in amplitude response) of the series-tuned circuit presented by a piezoelectric crystal at its natural frequency of oscillation, or of the parallel-tuned circuit formed by the crystal and its holder and associated external circuit (at its "antiresonant" frequency).

Pill-box antenna – A cylindrical parabolic reflector enclosed by two plates perpendicular to the cylinder, spaced so as to permit the propagation of only one mode in the desired direction of polarization. It is fed on the focal line.

Pitch – 1. Of a vehicle, an angular displacement about an axis parallel to the lateral axis of the vehicle.

2. In acoustics, that attribute of auditory sensation in terms of which sounds may be ordered on a scale extending from low to high.

Plan – The actions or capabilities needed to accomplish a mission.

Plane polarized wave – A transverse wave in which the displacements at all points along a line in the direction of propagation lie in a plane containing this line. Also termed "linearly polarized wave."

Plane wave – A wave in which the wave fronts are everywhere parallel planes normal to the direction of propagation.

Planning, the joint program for – The Joint Chiefs of Staff have approved a joint program for planning (JCS Memorandum of Policy No. 84) which provides annually for one joint strategic study, two joint strategic plans, a joint intelligence estimate for planning, and a joint research and development objectives document. (OPNAV 5000.19E)

Plasma – An ionized gaseous medium that contains approximately equal numbers of electrons and positive ions, making the resultant space charge essentially zero.

Polar diagrams – A system of coordinates in which a point is determined by the length and the angle of a line connecting the center of the diagram and the point.

Polar radiation pattern – The characteristic lobed pattern of varying field strength of radiation from a source.

Port – A place of access, usually two-terminal, in a circuit, through which energy may be applied or withdrawn, or measurements taken (i.e., input or output).

Portable equipment – Equipments provided with line cords so they can be operated from any convenient electric outlet or which can operate from a self-contained battery.

Power density – The value, in watts/meter^2, of a signal at or about a single frequency at a remote point in space. (ECAC)

Power density spectrum – A plot of power density values due to many different frequencies emanating from one source, as a function of frequency. (ECAC)

Power gain – In a given direction, 4π times the ratio of the radiation intensity in that direction to the total power delivered to the antenna.

Power provision for – "Power provision for" a specific installation means that the primary electrical, hydraulic and/or pneumatic power and distribution system shall be of sufficient capacity to permit later incorporation of the specific equipment without modification to the primary power and distribution system. This capacity is in addition to the excess capacity provided for growth in the load demand. "Power provision for" does not include electrical wiring, hydraulic or pneumatic lines, brackets, bolt holes, etc. The weight of the specific installation shall not be included in the weight empty category unless specifically stated otherwise.

Precipitation static – Static interference due to the discharge of large charges built up on aircraft or other object by rain, sleet, snow, or electrically charged clouds.

Precision – 1. The degree of exactness with which a quantity is stated.

2. The degree of discrimination or amount of detail; e.g., a 3-decimal digit quantity discriminates among 1000 possible quantities. A result may have more precision than it has accuracy; e.g., the true value of pi to 6 significant digits is 3.14159; the value 3.14162 is precise to 6 figures, given to 6 figures, but is accurate only to about 5.

Prediction model – An analytical process designed to represent phenomena and predict its behavior in stated situations. For example, a mathematical representation of certain characteristics of radar equipment and its distribution may be used to predict the level of radar interference in a given environment. (ECAC)

Preselectors – A variable-frequency tuned circuit, sometimes employing amplification tuned to the frequency of the desired signal. The preselector passes the desired signal to the mixer, but rejects received signals of other frequencies.

Preventive maintenance – That maintenance performed to keep an item in satisfactory operational condition by providing systematic inspection, detection, and prevention of incipient failure.

Probability distribution – The function relating the probability of the occurrence of an event versus the event. (ECAC)

Procedures. RDT&E budget – The Navy Department RDT&E budget contains the financial data which supports the Navy Department program. The DCNO(D) is responsible for the review of the consolidated program project listings submitted by the Chief of Naval Research and for their submittal to the ASN(R&D). (OPNAV 3900.8C)

Procedures, RDT&E program – The Navy Department Annual RDT&E Program is comprised of the individual projects planned in support of the SORs, ADOs, EDRs, NRRs, and Marine Corps requirements, and the necessary Range and Management Support projects for that fiscal year. The DCNO(D) is responsible for coordinating the Navy Department RDT&E Program and Program 6 of the Department of Defense Five-Year Force Structure and Financial Program. DCNO(D) is also responsible for assuring that those Navy Department RDT&E projects assigned to programs other than Program _ are adequately coordinated with the appropriate OPNAV and Marine Corps sponsors. (OPNAV 3900.8C).

Proficiency test – A test that measures an individual's skill level within a given specialty.

Program – 1. A plan for the accomplishment of a definite objective which is specific as to the time-phasing of the work to be done and the means proposed for its accomplishment, particularly in quantitative terms, with respect to manpower, materiel, and facilities requirements. Thus, a program provides a basis for budgeting.

2. A segment or element of a complete plan.

3. A budget account classification (DOD 5000.8)

4. A combination of program elements designed to express the accomplishment of a definite objective or plan which is specified as to the time phasing of what is to be done and how. Programs are aggregations of program elements and in turn aggregate to the total Five Year Defense Program. At present, there are ten programs in the FYDP.

Program budget decision (PBD) – A document originated in OSD during the annual budget review to record the decisions of the Secretary of Defense on the Department of the Navy's budget submission. (OPNAV 5000.19E)

Program change decision (PCD) – A document that announces the Secretary of Defense's decision on a PCR. (OPNAV 5000.19E)

Program change request (PCR) – A document used in the programming system to forward requested changes to the FYDP for review and action by the Secretary of Defense. PCRs are required also to reflect the program changes that develop from the decisions made during the DPM process. (OPNAV 5000.19E)

Program cost – The estimate of total obligational authority (TOA) required.

Program objectives (PO) – Provide the annual increments of the Navy and Marine Corps balanced force levels and programs necessary to progress in an orderly manner toward military objectives. The DNFYP portrays the SECDEF approved program. The PO records the Navy/Marine Corps requirements as approved by SECNAV. (E)

Project – A planned undertaking with a finite beginning and ending, involving definition, development, production, and logistic support of a major weapon or weapon support system or systems. A project may be the whole or a part of a program. Within the NMC, a designated project is a project which, because of its importance or critical nature, has been selected for intensified project management.

Project management – Management of a project, using organizational or procedural alignments, which will permit varying degrees of intensified direction. This may apply to management of a complete system or any portion thereof, and it may include all phases of development, production, and distribution, or be limited to a single phase such as development.

Project manager – The individual within the NMC, bureaus, and offices who is responsible, within well-defined boundaries of time, resources, and performance requirements, for executing an approved project.

Project master plan (PMP) – A compilation of planning documents prepared by the project manager, with assistance from participating organizations and contractors, which places in context the plans, schedules, costs, and scope of all work and resources to be provided by each participating organization. The master plan defines a management approach for acquiring items and services required to satisfy specified operational requirements. (NAVMAT 5000.5A).

Propagation – The traveling of a wave along a transmission path. It usually refers to the transmission of radio waves in space, or the transmission of electrical waves on a pair of wires or in cable.

Propagation, forward scatter – The transmission of microwave signals beyond line-of-sight distances. Forward scatter propagation uses very high power transmission and large antennas to obtain receivable signals over long distances.

Propagation model – An empirical or mathematical expression used to compute propagation path loss. (ECAC)

Propagation path loss – The reduction of the power level of a signal as it propagates from the output of the interfering or desired transmitting antenna to the input of the receiving antenna under consideration. (ECAC)

Proposed technical approaches (PTA) – Formal documents prepared by the Naval Material Command (NMC) and the bureaus and offices of the Navy Department by which technical approaches to achieve a particular capability are presented. (OPNAV 3910.8)

Provisioning, initial – The process of determining the range and quality of items such as spares and repair parts, special tools, and test equipment required to support and maintain an end item of material for an initial period of service. Its phases include the identification of items of supply, the establishment of data for catalog, technical manual, and allowance list preparation, and the preparation of instructions to assure delivery of necessary support items with related end articles. (SECNAV 4423.2A)

Pulse – A variation of a quantity whose value is normally constant (not necessarily zero); this variation is characterized by a rise and decay and has a finite duration.

Pulse amplitude modulation (PAM) – Modulation in which a wave controls the amplitude of a pulse carrier. PAM/FM – Frequency modulation of a carrier by pulses which are amplitude-modulated by information.

Pulse code – 1. A pulse train modulated to represent information.

2. Loosely, a code consisting of pulses, such as Morse code, Baudot code, binary code.

Pulse code modulation (PCM) – That form of pulse modulation in which a code is used to control the amplitude of the pulse carrier. PCM/FM – frequency modulation of a carrier by pulse code modulated information. PCM/FM/FM – frequency modulation of a carrier by subcarriers which are frequency modulated by pulse code modulated information. PCM/PM – phase modulation of a carrier by pulse code modulated information. PCM, parallel – a PCM technique in which the pulses are transmitted simultaneously over parallel channels and are usually detected by sampling all received outputs at the same instant. This technique is often encountered in magnetic tape recording. A simultaneous group of pulses may be referred to as a character or a word. PCM, serial – PCM transmission in which a single data channel is used and the pulse code signals are received in sequential order.

Pulse duration modulation (PDM) – Formerly pulse width modulation (PWM). PDM/FM – frequency modulation carried by subcarriers that are frequency-modulated by pulses modulated in duration by information. PDM/FM/FM – frequency modulation of a carrier by subcarriers which are frequency modulated by pulse-duration-modulated information.

Pulse position modulation (PPM) – PPM/AM – amplitude modulation of a carrier by pulses which are position-modulated by information.

Pulse repetition frequency (PRF) – The pulse repetition rate of a periodic train of pulses.

Pulse time modulation (PTM) – Modulation in which the values of instantaneous samples of the modulating waves are caused to modulate the time of occurrence of some characteristic of a pulse carrier.

Pulse width – The time interval during which a pulse exceeds a reference level. The reference level is generally taken as the half power points.

Q

Q. – 1. The figure of merit of efficiency of a circuit or coil. Numerically it is the ratio of the inductive reactance to the resistance of the circuit or coil: Q = X/R.

2. (Of a crystal) The ratio of reactance to resistance of a crystal at its natural frequency of oscillation.

Qualified products – Those products which, in accordance with specifications containing qualification requirements have been subjected to examination and tests and have been found to satisfy all requirements of the applicable specification. Qualified products lists identify the specification, manufactured item by part of model number or trade name, place of manufacture, and the test report involved. Suppliers whose products have successfully completed qualification testing and who furnish evidence thereof, are eligible for award although not yet included on the qualified products list. (Project 60)

Qualified products list (QPL) – A government-prepared or approved list of products, qualified under the requirements stated in the applicable specification, including appropriate identification and reference data with the name and plant address of the manufacturer. (Project 60)

Qualitative value – Quality considerations which improve system maintainability and minimize requirements for special tools, ground support equipment, facilities, manpower, high skill levels, training, inspection, servicing, and testing.

Quantitative value – A measurable unit of time, such as downtime, and effort required to accomplish a specific maintenance task in relation to the applicable performance requirements (e.g., reaction time, turn-around time, in commission rate, bench check time, bench repair time, calibration time).

Quartz-crystal filter – A crystal filter in which the piezoelectrically resonant elements are all either natural or synthetic quartz crystals.

Quieting sensitivity – The least signal input for which the output signal-to-noise ratio does not exceed a specified limit in FM receivers. This limit is usually stated as 30 dB.

R

RACON – A radio navigation system transmitting, automatically or in response to a predetermined received signal, a pulsed radio signal with specific characteristics whereby the bearing and range of the transponder from the interrogator can be determined.

Radant antenna – Antenna built into radome, or antenna which is its own radome, as dielectric lens and helisphere antennas.

Radar – Radio detection and ranging equipment that determines the distance and usually the direction of objects by transmission and return of electromagnetic energy

Radar echo – 1. The radio frequency energy received after reflection from an object.

2. Also describes the deflection or change of intensity on a cathode ray tube display produced by a radar echo.

Radar navigation – The use of radar to assist in navigation and pilotage.

Radar, navigational – Radar equipment used to assist in navigation and pilotage.

Radar recognition and identification – (IFF-identification, friend or foe.) A system using an interrogating transmission to which equipment carried by friendly forces automatically responds, for example, by emitting pulses, thereby distinguishing themselves from enemy forces. It is the primary method of determining the friendly or unfriendly character of aircraft and ships by other aircraft or ships and by ground forces using radar detection equipment and associated IFF units.

Radar shadows – Region obscured from the surveillance of a radar set by obstructions, either natural or artificial.

Radiac (Radioactivity detection, identification and computation) – Detection identification, and measurement of the intensity of nuclear radiation in an area.

Radiated emission – Radiation and induction field components in space. (MIL-STD-463)

Radiation – The emission and propagation of electromagnetic waves through space or a material medium spreading indefinitely through its environment.

Radiation device, incidental – A device that radiates radio frequency energy during the course of its operation although the device is not designed to radiate radio frequency energy. Examples: radio receivers, neon signs, electric motors, automotive ignition systems, and electrical relays.

Radiation device, restricted – A device in which the generation of radio frequency energy is intentionally incorporated into the design and in which the radio frequency energy is conducted along wires or is radiated, exclusive of transmitters which require licensing or authorization. Examples: radio receivers, carrier-current intercoms, low power (less than 100 milliwatt) communication devices, community antenna TV systems, and garage door openers.

NOTE. Present FCC regulations classify medical diathermy, RF-stabilized (HELIARC) welders, industrial RF heaters, etc. as industrial, scientific, or medical (ISM) devices that require licensing or certification.

Radiation efficiency – The ratio of the power radiated to the total power supplied to the antenna at a given frequency.

Radiation field pattern – A graphic representation of the radiation of an antenna as a function of direction.

Radiation hazard (RADHAZ) – Radiofrequency electromagnetic fields of sufficient intensity to produce harmful biological effects in human beings.

Radiation intensity – In a given direction, the power radiated from an antenna per unit solid angle in that direction.

Radiation resistance – The quotient of the power radiated by an antenna by the square of the effective antenna current referred to a specified point.

Radio direction finding (DF) – Radio location in which only the direction of a station is determined by means of its emission.

Radio fix – 1. The location of a friendly or enemy radio transmitter determined by finding the direction of the radio transmitter from two or more listening stations.

2. The location of a ship or aircraft by determining the direction of radio signals coming to the ship or aircraft from two or more sending stations, the locations of which are known.

Radio horizon – The locus of points at which direct rays from the transmitter become tangential to the earth's surface.

NOTE. On a spherical surface the horizon is a circle. The distance to the horizon is affected by atmospheric refraction.

Radiosonde – An automatic radio transmitter used as a meteorological aid, usually carried on an aircraft, free balloon, kite or parachute, which transmits meteorological data.

Radio sono-buoy – An instrument designed to receive underwater sonic noises and retransmit them for radio reception.

Radix – The quantity of characters for use in each of the digital positions of a numbering system. In the more common numbering systems, the characters are some or all of the Arabic numerals as follows:

System Name	Characters	Radix
Binary	(0,1)	2
Octal	(0,1,2,3,4,5,6,7)	8
Decimal	(0,1,2,3,4,5,6,7,8,9)	10

Unless otherwise indicated, the radix of any number is assumed to be 10. For positive identification of a radix 10 number, the radix is written in parentheses as a subscript to the expressed number as $126_{(10)}$. The radix of any nondecimal number is expressed in similar fashion: $11_{(2)}$ and $5_{(8)}$. Synonymous with base, base number, and radix number

Random (or fluxtuation) noise – Noise characterized by a large number of overlapping transient disturbances occurring at random. It is characterized by a peak-to-average noise level ratio in the order of 4:3 to 5:4. This is a type of broadband noise. Thermal and shot noise are typical examples.

Ratio detector – A type of FM detector that uses current opposition from the diodes to generate the signal. The detector also incorporates amplitude limiting and thus can be used without a limiter preceding the detector.

Reaction time – The time required to initiate a mission, measured from the time the command is received.

Ready time – The period of time during a mission that the item is available for operation but is not required. Different from alert time.

Receiver – An equipment or system specifically designed to respond selectively to radio-frequency energy.

Receiver area noise level – That receiver output obtained at a particular frequency with all controls at standard settings, all other subsystems and equipments turned off, and the receiver antenna connected.

Receiver bandwidth – The number of cycles per second expressing the difference between the limiting frequencies of the receiver pass band characteristics.

Receiver noise figure (NF) – The ratio of (1) noise power measured at the output of the receiver to (2) noise power which would be present at the output if the thermal noise due to the resistive component of the source impedance (at temperature of 290° Kelvin) were the only source of noise in the system. For heterodyne systems, the (2) noise power includes only that noise from the input termination that appears in the output via the principal frequency transformation of the system and does not include spurious contributions such as those from image-frequency transformations.

Receiver spurious response – Any response of a receiver to a signal outside its intended reception bandwidth.

Reclama – 1. A presentation by an agency requesting restoration of all or part of a reduction in a budget estimate made by a higher review level.

2. An appeal for reconsideration of any action. (DOD 5000.8)

Records – 1. Equipment-oriented records – Records in the E-file derived from the EEES using DD Form 1374. (ECAC)

2. Frequency oriented records – Records in the E-file obtained from records prepared by frequency management agencies such as the Interdepartmental Radio Advisory Committee (IRAC) and the Federal Communications Commission (FCC). These records contain only data pertaining to frequency management (frequency, power, modulation characteristics, and location), and do not contain environmental information such as equipment nomenclature, antenna information, equipment operating times, and operational modes. (ECAC)

Recovery time – 1. Of receiver: the time required for a receiver to recover to half sensitivity after the end of the transmitted pulse.

2. Of transmit-receive(TR) switch: time required after an RF pulse has fired the gap in the transmit-receive (TR) switch, for the received signal to reach half its maximum amplitude. See TR switch.

Recursive – Pertaining to an inherently repetitive process. The result of each repetition is usually dependent upon the result of the previous repetition.

Reference level (single sideband equipment) – The reference level for voice frequency input power to a single sideband transmitter shall be the power of one of two equal tones which together cause the transmitter to develop its full rated power output.

Reflection – That phenomenon which causes a wave that strikes a medium of different characteristics to be returned into the original medium with the angles of incidence and of reflection equal and lying in the same plane.

Reflection loss – The loss in transmission due to reflection of energy at a point of discontinuity or change of impedance, usually expressed as a ratio in decibels of difference between the incident power and the power absorbed by the load.

Reflector -- 1. A single rod, system of rods, or solid metal sheet used to increase the directivity of an antenna. See Antenna (Parabolic).

2. A microwave reflecting surface (usually flat) placed in a radio beam to change the direction of the beam.

Reflector, corner – A device, normally consisting of three metallic surfaces or screens perpendicular to one another, designed to act as a radar target or marker.

Refraction – That phenomenon which causes a wave that enters another medium obliquely to undergo an abrupt change in direction if the velocity of the wave in the second medium is different from that in the first.

Refractive index of air – The ratio of propagation velocity in a vacuum to the velocity in the atmosphere for electromagnetic radiation. At sea level, the refractive index is approximately 1.0003, decreasing at the rate of approximately 1.2×10^{-8} per foot with gain in altitude.

Regeneration – A method of securing increased output from an amplifier by feeding a part of the amplifier output back to the amplifier in such a way that the signal is in phase with the input. Also called "positive feedback."

Related areas – Topics which are of consequence under the broad heading of communication theory but are not appropriately assigned to the specific study of electromagnetic propagation.

Repair – The processes required to return an item to a specified condition including preparation, fault location, item procurement, fault correction, adjustment and calibration, and final test.

Request for proposal (RFP) – Describes the items to be procured, may include specifications, quantities, time and place of delivery, method of shipment, packaging and instruction manual requirements, and material to be furnished. The manufacturer is requested to submit a quotation supported by cost breakdown on the form provided. Government is not committed to pay any costs. Approximately 30 days are allowed the company to prepare and submit its proposal. (Navy Contract Law – 2nd Edition – Para. 12.11)

Request, procurement – The document that initiates procurement action; contains basic information in which a procurement plan can be established and is usually supplemented by the contract schedule, which consists of a description of items to be so procured, delivery dates, specification, and proposed contract terms. (BUWEPS 5200.25)

Research, naval – 1. Applied and basic research that is conducted for the purpose of acquiring new knowledge, methods, techniques, and materials to provide a general broad base for the continuing improvement of the Department of the Navy.

2. Naval research includes all items of research and development directed toward acquiring new knowledge, methods, techniques, and materials necessary to provide a general broad base for the continuing improvement of the Navy. (NAVSHIPS 250-331-1)

Resistance (R) – Electrical resistance is the factor by which the square of the instantaneous conduction current must be multiplied to obtain the power lost by heat dissipation or other permanent radiation of energy away from the electrical current.

Resistivity (ρ) – Electrical resistivity is a characteristic proportionality factor equal to the resistance of a centimeter cube of a substance to the passage of an electrical current perpendicular to two parallel faces. Also called specific resistance.

$$R = \rho\left(\frac{\ell}{A}\right)$$

where R is the resistance of a uniform conductor, ℓ is its length, A is its cross-sectional area, and ρ is its resistivity.

Residual magnetism – The amount of flux remaining in an iron core after the magnetizing current is reduced to zero.

Response curve – 1. A plot of stimulus versus output.

2. A plot of output versus frequency for a specific device.

Response, frequency – A measure of the ability of a device to take into account, follow, or act upon a varying condition; e.g., as applied to amplifiers, the frequencies at which the gain has fallen to the one-half power point or to 0.707 of the voltage gain, either at the high or low end of the frequency spectrum. When applied to a mechanical controller, the maximum rate at which changes in condition can be followed and acted upon, since it is implied that the controller can follow slow changes.

Rhombic antenna – An antenna composed of long-wire radiators comprising the sides of a rhombus. The antenna usually is terminated in an impedance. The side of the rhombus, the angle between the sides, the elevation, and the termination are proportioned to give the desired directivity.

Roll – The act of rolling; rotational or oscillatory movement of an aircraft or similar body about a longitudinal axis through the body, called "roll" for any degree of such rotation.

Rosebud antenna – Circular arrangement of inclined scimitar antennas with common narrow end feed points and separately grounded broad ends.

S

Safeguard, to – The term "to secure" a radio transmission is used to indicate that action is taken to ensure that it cannot be used by the enemy as a navigational aid. Safeguarding action may take the form of synchronizing, masking or spoiling, or some form of coding the navigational intelligence given by a system.

Schedule – 1. A subsidiary detailed financial statement or statistical table, generally in support of summary data in an exhibit.

2. That part of a contract which details of the property to be delivered or services to be performed, delivery terms, etc. (DOD 5000.8)

Scientific and technical information (STINFO) – Knowledge or data resulting from the conduct of research and development, and required for organizing, administering, or performing research and development. It encompasses any information, in recorded or other communicable form, which describes the status, progress, or results of research and development in any area of science or technology, and which has some potential use in advancing current and future research and development. (National Science Foundation 63-11)

Scimitar antenna – Half-loop antenna of scimitar shape fed at thin end and grounded at broad end, or vice versa.

Security – Refers to the safeguarding of information classified top secret, secret, or confidential (including confidential and modified handling authorized) against unlawful or unauthorized dissemination, duplication, or observation. (Project 60)

Selective fading – Fading of the skywave in which the carrier and various side band frequencies fade at different rates, causing audio frequency distortion.

Selectivity – The degree of falling off in the response of a resonant device with departure from the resonance; expressed as the ratio of the amplitude of response at the resonant frequency to the response at some frequency differing from the resonant frequency by a specified amount; determines the ability of a radio receiver to reject undesired signals.

Sensitivity – 1. The degree of response of a device to a specified input such as current or radio signals.

2. Of a measuring instrument, the magnitude of the deflection produced by a given change in the measured quantity.

3. Of a receiver, the smallest input signal capable of producing an output signal of a given magnitude, the modulating frequency and degree of modulation being specified.

4. Of a camera tube, the signal current developed per unit incident radiation, measured in watts per unit area.

Separation criteria – Curves which relate the frequency displacement to the minimum distance between a receiver and an undesired transmitter to insure that the signal-to-interference ratio does not fall below a specfied value. (ECAC)

Series, time — The discrete or continuous sequence of quantitative data assigned to specific moments in time, usually studied with respect to their distribution in time.

Set — A unit or units and necessary assemblies, subassemblies, and parts connected or associated to perform an operational function. Also a collection of like parts such as a "tool set" or a "set" of tires. (Examples: Radio receiving set; sound measuring set, which includes such parts, assemblies, and units as cable, microphone and measuring instruments; radar homing set.)

Shape factor — A measure of the sharpness of cut-off (or steepness of slope) in the transition region between pass band and stop band. In symmetrical band-pass filters, it is the ratio of the frequency difference (Hz) between the specified high-attenuation points to the frequency difference between the specified cutoff points, of the pass band. In symmetrical band-rejection filters, it is the reciprocal of this ratio. In asymmetrical filters, the ratio of the frequency difference between center frequency and the specified high attenuation point on either side to that between center frequency and the specified cutoff point on the same side, i.e., there are two shape factors, of different ratio, one on the "steep side," one on the "gradual side," of the center frequency.

Shield — A shield is a conducting enclosure surrounding a source of interference or a susceptible circuit, designed to reduce the radiation of interference or to prevent a susceptible circuit from being affected by interfering signals.

Shielded room – An enclosure designed primarily to reduce the transmission, reception, or propagation of electromagnetic energy. Either the electric (E) component or the magnetic component (H) of the field may be attenuated, or both may be attenuated.

Shielding effectiveness – The ratio, usually expressed in decibels, of noise or induced current or voltage in a system element when a source of shielding is present, to the corresponding quantity when the shielding is absent.

Sidebands — 1. The frequency bands on both sides of the carrier frequency within which fall the frequencies of the wave produced by modulation.

2. The wave components lying within such bands.

NOTE. In the process of amplitude modulation with a sine-wave carrier, the upper sideband includes the sum (carrier plus modulating) frequencies; the lower sideband includes the difference (carrier minus modulating) frequencies.

Sideband splatter — Those emissions that appear outside of the necessary bandwidth and are a result of intermodulation products of the modulation spectrum being transmitted.

Sidelobe — A portion of the radiation from an antenna outside of the main beam and usually of much less intensity. A sidelobe is a region between two minima of the antenna pattern.

Signal — 1. As applied to electronics, any transmitted electrical impulse.

2. Operationally, a type of message, the text of which consists of one or more letters, words, characters, signal flags, visual display, or special sounds, with prearranged meanings, which is conveyed or transmitted by visual, accoustical, or electrical means.

Signal density — A tabulation or a graphical plot of power densities as a function of source frequency from multiple sources. (ECAC)

Signal separation filter — A bandpass filter that selects the desired subcarrier channel from the FM composite.

Signal-to-noise ratio — The ratio of the value of the signal to that of the noise. This ratio is usually in terms of peak values in the case of impulse noise and in terms of the root-mean-square values in the case of the random noise.

Where there is a possibility of ambiguity, suitable definitions of the signal and noise should be associated with the term, as, for example: peak-signal to peak-noise ratio; root-mean-square signal to root-mean-square noise ratio; and peak-to-peak signal to peak-to-peak noise ratio.

This ratio may be a function of the bandwidth of the transmission system. It is often expressed in decibels.

Simplex operation of a radio system — A method of operation in which communication between two stations takes place in one direction at a time. This includes ordinary transmit-receive operation, press-to-talk operation, voice-operated carrier, and other forms of manual or automatic switching from transmit to receive.

Single sideband modulation (SSB) — Modulation whereby the spectrum of the modulating wave is translated in frequency by a specified amount, either with or without inversion.

Single-sideband transmission — That method of operation in which one sideband is transmitted and the other sideband is suppressed. The carrier wave may be either transmitted or suppressed.

Skew — Tape motion characterized by an angular velocity between the gap center line and a line perpendicular to the tape center line.

Skin effect — Refers to the phenomena wherein the depth of penetration of electric currents into a conductor decreases as the frequency of the current is increased. At very high frequencies, the current flow is restricted to an extremely thin outer layer of the conductor.

Slew — To change the position of an antenna by injecting a synthetic error signal into the positioning servo-amplifier.

Slot antenna — A radiating element formed by a slot in a metal surface.

Smith charts — A series of transmission-line charts in polar plot form used for the interpretation of measured values of VSWR or reflection coefficients. It can also be used for determining the effect of a discontinuity or a change in characteristic impedance, and for solving impedance-matching problems.

Software — The totality of programs and routines used to extend the capabilties of computers, such as compilers, assemblers, narrators, routines, and subroutines. Contrasted with hardware.

Solder — Solder is a single metal or an alloy of two or more metals which, when melted, is used to join metallic surfaces through the phenomenon of wetting.

Soldered connection — A soldered connection is an electrical connection or a mechanical joint (including a hermetic seal) in which solder bonds two or more metals with an alloy (solder).

Solid state — The electronic components that convey or control electrons within solid materials; e.g., transistors, germanium diodes, and magnetic cores. Vacuum and gas tubes are not included.

Source impedance — The impedance across the output terminals of a transducer presented by the transducer to the associated external circuitry.

Sourcing — Generally, sourcing means redesign or modification of existing equipment to eliminate a source of RFI. When sourcing is not feasible, engineers are forced to resort to suppression, filtering, or shielding.

Space attenuation (space loss) — A power loss, expressed in dB, of a signal in free space, caused by such factors as absorption, reflection, scattering, and dispersion.

Space provision for — "Space provision for" a specific installation means that space only shall be allocated for the installation, and that brackets, bolt holes, electrical wiring, hydraulic lines, etc. are not required. "Space provision for" does not imply that adequate attaching structure is provided unless otherwise stated. The weight of the specific installation shall not be included in weight empty measurements unless specifically stated.

Specific operational requirement (SOR) — A document by which the CNO states the need for the development of a particular operational capability. It normally follows and is based on the information in a PTA. (OPNAV 3910.6)

Specification, military — Document intended primarily for use in procurement, which includes clear, accurate descriptions of the technical requirements for items, materials, or services including the procedures by which it will be determined that the requirements have been met. Specifications for items and materials also contain preservation, packaging, packing, and marking requirement. (Project 60)

Spectrum — 1. The entire range of wavelengths or frequencies within which electromagnetic radiations occur, bounded at one end by the longest radio waves and at the other by shortest known cosmic rays.

2. A segment of wavelengths that has a special function or special properties. For example, the radio spectrum extends from about 20,000 cps to over 30,000 megacycles, and the light spectrum, changing gradually from deep red at one end to violet at the other, lies approximately at the middle of the overall spectrum. Within the radio spectrum there are spectra such as the very-low frequency, low frequency, and medium frequency.

3. A graph or display of frequency versus power.

Spectrum signature – The spectral characteristics of the transmitter, receiver, and antenna of an electronic system. These characteristics have an important effect on either the generation or reception of electromagnetic energy. The signature includes emission spectra, antenna patterns, receiver selectivity and spurious responses, intermodulation sensitivity, and other characteristics. (ECAC)

Spectrum signature measurement reports – A printed volume containing measured spectrum signature data, with reference to or description of the standardized procedures used to obtain the data. (ECAC)

Spherical wave – A wave whose equiphase surfaces form a family of concentric spheres.

Spurious emission – Any electromagnetic emission from the intended output terminal of an electronic device, outside of the designed emission bandwidth. Spurious emissions include harmonics, parasitic emissions, and intermodulation products, but exclude unnecessary modulation sidebands of the fundamental frequency. (MIL-STD-463)

Spurious response – Any response of an electronic device to energy outside its designed reception bandwidth through its intended input terminal. MIL-STD-463

Standard response – The programmed or desired response produced in a test item by a specified input signal. The standard response can be used to measure any deviation from normal performance which occurs during susceptibility testing (e.g., signal plus noise-to-noise on a receiver for a specified input signal).

Standing wave – A wave in which, for any component of a field, the ratio of its instantaneous value at one point to that at any other point does not vary with time.

Station – One or more transmitters or receivers or a combination of both, including the accessory equipment necessary at one location for carrying on radiocommunication. Each station shall be classified by the service in which it operates permanently or temporarily.

Structure – Any movable or stationary body such as an airframe, ship's hull, tank, trailer, building framework, or shelter.

Stub antenna – Short antenna extending from ground-plane.

Subassembly – Two or more parts which form a portion of an assembly or a unit replaceable as a whole. but having a part or parts which are individually replaceable. (Examples: Gun mount stand, window sash, recoil mechanism, floating piston, telephone dial, IF strip, terminal board with mounted parts, power shovel dipper stick.)

Subcarrier – A carrier which is applied as modulation on another carrier or on an intermediate subcarrier.

Substitution measurements – A method of measuring signals which depends on the use of a calibrated signal generator with an output similar to that of an unknown signal. The calibrated signal is substituted for the unknown signal to reproduce the instrument response. The error is then limited to the error of the calibrated signal source.

Subsystem – A major functional element of a system, usually consisting of several equipments essential to the operational completeness of the subsystem or system. Examples are airframe, propulsion, guidance, navigation, and communication.

Sunspot – Dark spots on the sun's surface, the larger of which are visible to the naked eye when viewing the sun through a dark glass. Sunspots appear to be areas of solar activity.

Sunspot cycle – Sunspot activity follows a cycle with an average of 11.1 years between successive minima. The usual cycle shows the variation of the 12-month running average number of sunspots plotted against the months.

Support, contractor – An interim arrangement during initial development or production of an equipment whereby a contractor is obligated to furnish to the Government, either from production or from stocks maintained by him, items for support of the equipment as required, pending assumption of support responsibility by the Government. (SECNAV 4423.2)

Support – A composite of related facilities, equipment, material, services, and personnel required for the operation and maintenance of the system, so that it can be considered self-sufficient in its operational environment.

Suppression – The elimination of unwanted signals or interference by means of shielding, filtering, grounding, component relocation, or sometimes, redesign.

Surveillance radar/warning search radar - A radar with the normal function of:

(1) Maintaining continuous watch or search.

(2) Supplying information on all targets with sufficient accuracy to permit transference to other more accurate radars in time to allow engagement of targets at maximum range.

Susceptibility – The characteristic of electronic equipment that permits undesirable responses when subjected to electromagnetic energy. (MIL-STD-463)

Sweep – A term designating the wave applied to either set of dielecting plates (or coils) of a cathode-ray tube, usually the horizontal plates, for the purpose of deflecting the electron beam in a prescribed manner. For example, a sawtooth sweep is a waveform in which the increase of voltage or current is a linear function of time.

Sweep oscillator – A signal generator in which the frequency is varied continuously over a predetermined range, the variation being repeated at a low frequency rate.

Synchro – The universal term applied to any of the various synchronous devices such as the selsyn, autosyn, motor-torque generator, mag-slip, and Siemens.

Synchronization – The precise matching of two waves or functions. In relation to carrier frequencies, that degree of matching of frequency of the carrier used for modulation and the carrier used for demodulation. It is sufficiently accurate to permit efficient functioning of the system. A few cycles per second mismatch causes no perceptible loss of performance.

Synthesis – The combining of parts in order to form a whole; e.g., to arrive at a circuit or a computer or program, given the performance requirements. This can be contrasted with analysis, which arrives at performance, given the circuit or program.

Synthesized equipment parameters – Those characteristics determined by empirical or theoretical means. Nominal characteristics may be used in the process. (ECAC)

Synthesized spectrum signatures – The spectrum signature information which was obtained by mathematically manipulating the known nominal characteristics to obtain additional related theoretical characteristics of electronic equipments. (ECAC)

System – A combination of two or more interrelated equipments (sets) arranged in a functional package to perform an operational function or to satisfy a requirement, e.g., ship system, weapon system, communication system, navigation system, fire control system, aircraft system. (BUSHIPS 5430.38)

System, aircraft – A combination of those inter-related aircraft end items (excluding the expendable military payload) of a specific type aircraft and its peculiar support equipment in functional packages to meet an operational requirement. Also defined as the complete entity of an aircraft or astronautics vehicle including the airframe or rocket propulsion machinery, armament, electrical, electronic and mechanical equipment. (BUSHIPS 5430.38)

System (electrical – electronic) – A combination of two or more sets, generally physically separated when in operation, and such other assemblies, subassemblies, and parts necessary to perform an operational function or functions. (Examples: AEW electronic system, antiaircraft defense system, telephone carrier system, GCA electronic system, fire control system including the tracking radar, computer, and gun mount.)

System (general) – A combination of parts, assemblies, and sets joined to perform a specific operational function or functions. (Examples: Piping system, refrigeration system, air conditioning system.)

System, naval communication – The world-wide network of transmitting and receiving stations designed and built to provide world-wide and local communications service to the

Navy ashore and afloat; provides common user facilities and facilities for special communication requirements. (BUSHIPS 5430.38)

System, Navy planning and programming – This system serves three basic purposes. First, it provides for the development of Navy concepts, requirements, and objectives, and for their presentation to higher authority to introduce the Navy's viewpoint into Joint, Department of Defense, and Department of the Navy program planning which resolves annually into the Department of the Navy's budget submission to the Secretary of Defense. Second, it provides a framework for the translation of strategic and operational concepts, technological and intelligence forecasts, as well as guidance received from higher authority, into research and development, force level, personnel and support plans and objectives. Third, it provides guidance and direction for the use of current capabilities. (OPNAV 5000.19E)

System, number – 1. A systematic method for representing numerical quantities in which any quantity is represented as the sequence of coefficients of the successive powers of a particular base with an appropriate point. Each succeeding coefficient from right to left is associated with and usually multiplies the next higher power of the base. The first coefficient to the left of the point is associated with the zero power of the base. For example, in decimal notation, 371.426 represents $(3X10^2) + (7X10^1) + (1X10^0) + (4X10^{-1}) + (2X10^{-2}) + (6X10^{-3})$.

2. Following are names of the number systems with bases 2 through 20: 2, binary; 3, ternary; 4, quaternary; 5, quinary; 6, senary; 7, septenary; 8, octal, or decimal; 12, duodecimal; 13, terdenary; 14, quaterdenary; 15, quindenary; 16, sexdecimal, or hexadecimal; 17, septendecimal; 18, octodenary; 19, novemdenary; 20, viceanry. Also widely used in computers are 32, duosexadecimal, or duotricinary; and 60, sexadecimal systems.

Systems analysis – "Tracing out some of the consequences of alternative weapons or actions and exhibiting these consequences to decision makers." (R.N. McKean)

T

Target acquisition – The process of positioning the tracking apparatus of a radar so that a designated target is gated in the display.

Technical – Relates to highly refined requirements, specific procedures, functions or acts necessary to properly accomplish or evaluate the accomplishment of a process or function. These requirements are usually delineated by engineering personnel. (Project 60)

Technical development plan (TDP) – A TDP is a plan prepared by the NMC or the cognizant systems command to document those actions, procedures, and resources required to achieve the capability described in the SOR, or those actions required to achieve the objectives outlined in an ADO. The TDP will include plans for development, production, installation, integrated logistic support, reliability, maintainability, test and evaluation, and personnel training for the project. The TDO will also provide cost estimates if it has been determined that formal contract definition will be used; the TDP shall contain a plan for contract definition. The TDPs are revised when program changes are approved, when significant changes in the program occur, and annually on 1 April. (OPNAV 3900.8C).

Telemetering – 1. Measurements accomplished with the aid of intermediate means which allow perception, recording, or interpretation of data at a distance from a primary sensor. The widely used interpretation of telemetering restricting its significance to data transmitted by means of electromagnetic propagation is more properly called telemetry.

2. A system for taking measurements within an aerospace vehicle in flight and transmitting them by radio to a ground station, where the information is processed for readout.

Tentative specific operational requirement

(TSOR) – The TSOR is a requirement document prepared by the CNO and addressed to the CNM or the cognizant bureau outside of the NMC. Generally, the TSOR is the initial step in the formal exchange of documents between the user and producer in the RDT&E planning cycle. The TSOR is, therefore, the first step toward defining the system, its characteristics, its deployment and its procurement, operation, and maintenance costs. The TSOR will tentatively state a requirement for a particular capability, identify an anticipated threat, outline the operational concept, define those performance and operational characteristics which can be specified, and indicate when the capability is needed. Promulgation of a TSOR by the CNO does NOT establish a firm requirement and does NOT authorize commencing a new development program. The NMC or cognizant systems command will respond to a TSOR by means of a PTA. (OPNAV 3900.8C)

Terminal impedance – The terminal impedance is the complex impedance as seen at the unloaded output or input terminals of a transmission equipment or line which is otherwise in normal operating condition.

Termination, contract – As used in DOD procurement, refers to the cessation or cancellation in whole or in part of work under a prime contract or a subcontract thereunder, for the convenience of or at the option of the Government. (Project 60)

Terrain elevation data – A table of elevations above sea level versus latitude and longitude, which can be used in determining input parameters for propagation path loss calculations. (ECAC)

Test antenna – One of specified characteristics designated for use under specified conditions in conducting tests in accordance with MIL-STD-461 and MIL-STD-462. (MIL-STD-463) .

Test, engineering – A test conducted by or under the supervision of the developing agency concerned, with an engineering approach, where the objective of the test is to determine the technical performance and safety characteristics of an item or system and its associated tools and test equipment as described in the QMR, the technical characteristics, and as indicated by the particular design. This determination includes the measurements of the inherent structural, electrical, or other physical and chemical properties of an item or system, including the effects of environmental stresses on these properties. The test is characterized by controlled conditions and the elimination of human errors in judgment, so far as possible, through the use of physical measurement techniques, controlled field trials, statistical methodology, and the use of personnel trained in the engineering or scientific fields. The engineering test provides data for use in further development and for determining the technical and maintenance suitability of the item or system for service test. (Project 60)

Test, environmental – An engineering test performed to evaluate the effects of natural climates or induced conditions of cold, heat, wind, moisture, radiation on the properties and performance of a product. (Project 60)

Test item – Any separate and distinct component or subsystem which, if procured separately, would normally be subject to applicable tests, as required by the specification. This term is used for brevity to refer to the item under test in a test plan or test report, regardless of whether it is a component or a subsystem.

Thermal noise (resistance noise) – Thermal noise is random noise in a circuit associated with the thermodynamic interchange of energy necessary to maintain thermal equilibrium between the circuit and its surroundings.

Thermistor – A specially constructed resistor that has a negative temperature coefficient, used for power measurements.

Thermocouple – A device consisting of two dissimilar metals in physical contact, which thereby form a thermo-junction across which a voltage is developed when the junction is heated. An instrument comprising a thermocouple, or thermocouples, connected to a meter calibrated in units of temperature is one of many types of pyrometers used to measure high temperatures. A thermocouple heated by RF current and connected to a DC meter serves as an RF ammeter when the meter is calibrated in amperes, and as an RF voltmeter when the meter is calibrated in volts.

Threshold – A definite level in some physical quantity at which a specified effect occurs.

Thresholds (DOD programming system) – A set of criteria which, if met or exceeded, requires the submission of a program change request to the office of the Secretary of Defense.

Time-division multiplex – The process or device in which each modulating wave modulates a separate pulse subcarrier, the pulse subcarriers being spaced in time so that no two pulses occupy the same time.

NOTE. Time division permits the transmission of two or more signals over a common path by using different time intervals for the transmission of the intelligence of each message signal.

Time, rise – The time required for the leading edge of a pulse to rise from one-tenth of its final value to nine-tenths of its final value.

Time delay of a filter (sometimes called "envelope delay" or "group delay") – At a particular frequency, equal to the first derivative of the differential phase at that frequency – i.e., the slope of the phase characteristic at that frequency, with phase measured in radians and frequency in radians per second.

Total obligational authority (TOA) – TOA is the total funding available for programming in a given year, regardless of the year the funds are appropriated, obligated, or expended. TOA includes new obligational authority, unprogrammed or reprogrammed obligational authority from prior years, reimbursements not used for replacement on inventory in kinds, advance funding for programs to be financed in the future, and unobligated balances transferred from other appropriations.

TR switch – Abbreviation for transmit-receive switch. A switch used in a radar antenna feed system to prevent the transmitter power from damaging the receiver where a common transmitting and receiving antenna is used. It automatically decouples the receiver from the antenna during the transmitting period. TR switches usually combine a gas discharge tube with a resonant cavity to produce the switching action.

Tracking antenna – A directional antenna system that automatically changes in position or characteristics to follow the motion of a moving signal source.

Trade-off – In design and manufacture, the improvement of one parameter at the expense of another; e.g., shape-factor reduction at the expense of insertion-loss reduction, or either against cost.

Transducer – A device by means of which energy can flow from one or more transmission systems to one or more other transmission systems. The energy transmitted by these systems may be of any form – electric, mechanical, or acoustical – and it may be of the same form or different forms in the various input and output systems.

Transfer function – In networks, the mathematical relation between input and output amplitude and phase, as a function of frequency.

Transient – 1. A physical disturbance, intermediate, to two steady-state conditions.

2. Pertaining to rapid change.

3. A build-up or breakdown in the intensity of a phenomenon until a steady state condition is reached. The time rate of change of energy is finite and some form of energy storage is usually involved.

4. A momentary surge on a signal or power line. May produce fake signals or triggering impulses.

Transition region or band – The range of frequencies between pass band and stop band over which attenuation increases sharply or gradually from low (pass) levels to high (stop) levels, or decreases from high to low.

Transmission, double sideband – Double sideband transmission is that method of communication in which the frequencies produced by modulation are symmetrically spaced both above and below the carrier frequency and are all transmitted.

Transmission, independent sideband – Independent sideband transmission is that method of communication in which the frequencies produced by modulation on opposite sides of the carrier are not related to each other, but are related separately to two sets of modulating signals. The carrier frequency may be either transmitted or suppressed.

Transmission lines – A transmission line is a material structure forming a continuous path from one place for the transmission of electric or electromagnetic energy. The term "transmission line" includes telephone lines, power cables, wave-guides, coaxial cables, and similar items.

Transmission media – The substrata (material or non-material) in which a given system of physical entities exists and through which electromagnetic waves propagate.

Transmission, single sideband – Single sideband transmission is that method of communication in which the frequencies produced by modulation on one side of the carrier are transmitted and those on the other side are suppressed. The carrier frequency may be either transmitted or suppressed.

Transmission, suppressed carrier – Suppressed carrier transmission is that method of communication in which the carrier frequency is suppressed either partially or to the maximum degree possible. One or both of the sidebands may be transmitted.

Transmitter – A device used to generate signals of any type and form which are to be transmitted. In radio and radar, it is that portion of the equipment which includes electronic circuits designed to generate, amplify, and shape the radio-frequency energy that is delivered to the antenna where it is radiated into space.

Transverse electric wave (TE wave) – In a homogeneous isotropic medium, an electromagnetic wave in which the electric field vector is everywhere perpendicular to the direction of propagation.

Transverse electromagnetic wave (TEM wave) – In a homogeneous isotropic medium, an electromagnetic wave in which both the electric and magnetic field vectors are everywhere perpendicular to the direction of propagation.

Transverse interference -- The interference occurring across terminals or between signal leads.

Transverse magnetic wave (TM wave) – In a homogeneous isotropic medium, an electromagnetic wave in which the magnetic field vector is everywhere perpendicular to the direction of propagation.

Traveling plane wave – A plane wave each of whose frequency components has an exponential variation of amplitude and a linear variation of phase in the direction of propagation.

Triboelectricity – Electric charges generated by friction, as the friction of dust particles on an airplane skin.

Troposphere – That part of the earth's atmosphere in which temperature generally decreases with altitude, clouds form, and convection is active. Experiments indicate that the troposphere occupies the space above the earth's surface to a height of about 10 kilometers.

Tropospheric wave -- A radio wave that is propagated by reflection from a place of abrupt change in the dielectric constant or its gradient in the troposphere. In some cases, the ground wave may be so altered that new components appear to arise from reflections in regions of rapidly changing dielectric constants; when those components are distinguishable from the other components, they are called tropospheric waves. (ASA)

Troubleshooting – Locating and diagnosing malfunctions or breakdowns in equipment by systematic checking or analysis.

Tuning band – That partial range of the tuning frequency over which a particular configuration of equipment operates with a given bandswitch setting: for example, one head of the AN/URM-XX may have the following tuning bands:

Band 1	0.15 to 0.4 MHz
Band 2	0.35 to 0.92 MHz
Band 3	0.9 to 2.45 MHz

Tuning frequency range – That partial range of the frequency over which a particular configuration of equipment operates: for example, following is a portion of an AN/URM-XX tuning frequency range:

0.15 to 30 MHz with head T-1 installed
20 to 220 MHz with head T-2 installed
200 to 410 MHz with head T-3 installed

Two-level antenna pattern – A simplified presentation of an antenna pattern consisting of a main beam gain level and a sidelobe gain level. (ECAC)

U

Unacceptable response – An unacceptable response is an abnormality in the required operation or output of a subsystem or equipment due to electromagnetic interference which cannot be designated a malfunction but which is detrimental to system performance.

Undesirable response – A recognizable interruption of normal output of a subsystem which cannot be designated as an unacceptable response or malfunction and which is considered tolerable by the procuring activity.

Uniconductor waveguide – A waveguide consisting of an arbitrary shaped metallic surface surrounding a dielectric medium.

Unintended radiation – Unintended radiation includes incidental radiation, spurious and harmonic outputs from transmitters, and outputs from industrial, scientific, and medical equipment; in short, man-made radio noise.

Unit – An assembly or any combination of parts, subassemblies, and assemblies mounted together, normally capable of independent operation in a variety of situations, such as a hydraulic jack, electric motor, electric generator, radio receiver. The size of an item is a consideration in some cases. An electric motor for a clock may be considered a part because it is not normally disassembled.

Unmodulated CW field sensitivity – That unmodulated CW field intensity which will produce a unity signal-to-noise power ratio at the RF or IF output of the interference measuring set. The point of measurement and the noise bandwidth to that point should be stated.

Units of measure:

a. Electric field intensity: dB uV/m

b. Magnetic field intensity: dB uA/m

The manufacturer should furnish data relating the field intensity as a function of frequency to the interference measuring set input level or the antenna-induced voltage, depending on whether shunt or series calibration, respectively, is used.

Unmodulated CW sensitivity – The unmodulated CW power input to an interference measuring set which will produce a unity signal-to-noise power ratio at the output of the RF or IF portion of the set. The point of measurement and the noise bandwidth to that point should be stated.

Unnecessary modulation sidebands – Modulation sidebands are the energy distributed about the fundamental and are a result of the modulation process for the transmission of intelligence. Unnecessary modulation sidebands are the sidebands outside of the necessary bandwidth.

V

V antenna – A V-shaped arrangement of conductors balanced-fed at the apex, and with included angle, length, and elevation proportioned to give the desired directivity.

Valentine antenna – Two coplanar scimitar-type antennas with broad ends joined and narrow ends brought together to form feed point.

Vector – A quantity that has both magnitude and direction or an arrow drawn in the direction and whose length is proportional to the magnitude of the quantity.

Velocity modulated oscillator (Klystron) – An electron-tube in which the velocity of an electron stream is varied (velocity-modulated) in passing through a resonant cavity called a buncher.

Verification – The process of substantiating the accuracy and completeness of technical directions for operation or maintenance by actually performing the operation or maintenance in accord with those directions. Normally applied to procedures contained in technical manuals.

Volt – The unit of electrical potential difference and electromotive force equal to the difference of potential across one ohm carrying a constant current of one ampere.

Vulnerability – The susceptibility of a system to degradation to the point of mission failure.

W

Watt – The unit of electrical power. The rate of doing work represented by a current of one ampere under a potential difference of one volt. Work done at the rate of one absolute joule per second.

Wave dynamics – The mathematical and physical description of wave motion and its properties.

Waveguide – A device of complex design used to transmit RF energy at high frequencies. In RFI work, waveguide design principles are used to design some utility penetrations for ventilation, etc. through which RF energy cannot pass.

Wave impedance – The impedance at a given frequency of traveling wave defined by the ratio of the electric field strength to the magnetic field strength. It is analogous to the characteristic impedance of a transmission line.

Weapon – An instrument of offensive or defensive combat which contains destructive force, used to destroy the enemy. (Project 60).

Weapon system – The complete system required to deliver a weapon to its target, including production, storage, transport, launchers, aircraft, and guidance equipment.

Whip antenna – Flexible vertical antenna mounted on vehicle or manpack radio.

White noise – A sound or electromagnetic wave whose spectrum is continuous and uniform as a function of frequency.

Word – An ordered set of characters which occupies one storage location and is treated by the computer circuits as a unit and transferred as such. Ordinarily a word is treated by the control unit as an instruction, and by the arithmetic unit as a quantity. Word lengths may be fixed or variable depending on the particular computer.

Wullenweber antenna – Direction-finding circular array around a cylindrical reflector. Limited sector of delay-line-collimated elements can be positioned on any azimuth.

X

Xerography – A dry copying process involving the photo electric discharge of an electrostatically charged plate. The copy is made by tumbling a resinous powder over the plate, the remaining electrostatic charge is discharged, and the resin transferred to paper or an offset printing master.

Y

Yagi or Yagi-Uda antenna – An end-fire antenna consisting of driven dipole with parasitic dipole reflector and one or more parasitic dipole directors. Driven dipole is usually a folded dipole, and all the antenna elements usually lie in a plane. The parasitic elements need not be coplanar but can be distributed on both sides of the plane of symmetry.

Yaw – The rotational or oscillatory movement of an aircraft or rocket about a vertical axis.

Year, fiscal – Twelve-month period selected for accounting purposes. (The fiscal year for most agencies of the United States Government begins on the first day of July and ends on the thirtieth day of June of the following calendar year.) The fiscal year is designated by the calendar year in which it ends, i.e., the fiscal year 19X1 is the year beginning 1 July 19X0 and ending 30 June 19X1. (DOD 5000.8)

Z

Zenith – That point of the celestial sphere vertically overhead.

Zeppelin antenna – End-fed half-wave dipole with quarter wave matching section.

Zener diode – A specifically designed P-N junction type diode which will maintain a constant back EMF over an appreciable range of current.

Zero – A numeral normally denoting lack of magnitude. In many computers there are distinct representations for plus and minus zero.

Zero transmission level reference – The zero transmission level reference point is an arbitrary chosen point in a circuit to which all relative transmission levels are referred. The transmission level at the transmitting switchboard is frequently taken as the zero transmission level reference point.

Zone, neutral – An area in space or an interval of time in which a state of being other than the implementing state exists; e.g., a range of values in which no control action occurs or a brief period between words when certain switching action takes place. Similar to band, dead.

2. JOINT ARMY-NAVY SYSTEM DESIGNATORS

INSTALLATION	EQUIPMENT	PURPOSE
A – Airborne	A – Infrared	A – Auxiliary
B – Underwater	B – Pigeon	B – Bombing
C – Air transportable	C – Carrier (wire)	C – Communications
D – Pilotless carrier	D – Radiac	D – Dir. finding/recon
F – Fixed	E – Nupac	E – Ejection/release
G – Ground	F – Photographic	G – Fire control
K – Amphibious	G – Telegraph-teletype	H – Record-reproduce
M – Ground, mobile	I – Interphone/PA	K – Computing
P – Pack or portable	J – Electromechanical	L – Searchlight control
S – Surface craft	K – Telemetering	M – Maintenance/test
T – Ground, transportable	L – Countermeasure	N – Navigation aids
U – General utility	M – Meteorological	P – Reproducing
V – Ground, vehicular	N – Sound in air	Q – Special purposes
W – Water, surface and underwater	P – Radar	R – Receiving
	Q – Sonar	S – Detect/range/bearing
	R – Radio	T – Transmitting
	S – Special types	W – Control
	T – Telephone (wire)	X – Ident. and recognition
	V – Visible light	
	W – Armament	
	X – Facsimile or TV	
	Y – Data processing	

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3. FREQUENCY BAND DESIGNATORS

ITU Nomenclature Table

Band	Range	Designation
4	3–30 kHz	VLF, very low frequency
5	30–300 kHz	LF, low frequency
6	300–3000 kHz	MF, medium frequency
7	3–30 MHz	HF, high frequency
8	30–300 MHz	VHF, very high frequency
9	300–3000 MHz	UHF, ultra-high frequency
10	3–30 GHz	SHF, super-high frequency
11	30–300 GHz	EHF, extremely high frequency

This table is taken from the Radio Regulations of the International Telecommunications Union (ITU), Article 2, Section 11, Geneva, 1959.

Microwave Bands

Band	Frequency Range	Wavelength, Cm
P	225–390 MHz	133.3–76.9
L	390–1550 MHz	76.9–19.3
S	1.55–5.2 GHz	19.3–5.77
X	5.2–10.9 GHz	5.77–2.75
K	10.9–36.0 GHz	2.75–0.834
Q	36.0–46.0 GHz	0.834–0.652
V	46.0–56.0 GHz	0.652–0.536
W	56.0–100.0 GHz	0.536–0.300

The following are also frequently used:

C Band includes 3.9-6.2 GHz
K_l Band includes 15.35–24.50 GHz
K_u Band includes 15.35–17.25 GHz
K_a Band includes 33.0-36.0 GHz

Letter designations commonly used for microwave bands, particularly in reference to radar equipment, have no official standing. Various organizations use limits for the bands other than those shown in the table.

4. RADIO EMISSION DESIGNATORS

DESIGNATION OF EMISSIONS

Emissions are designated according to their classification and their necessary bandwidth.

CLASSIFICATION

Emissions are classified and symbolized according to the following characteristics:

(1) Type of modulation of main carrier
(2) Type of transmission
(3) Supplementary characteristics

(1) TYPES OF MODULATION OF MAIN CARRIER	SYMBOL
(a) Amplitude	A
(b) Frequency (or phase)	F
(c) Pulse	P

(2) TYPES OF TRANSMISSION	
(a) Absence of any modulation intended to carry information	0
(b) Telegraphy without the use of a modulating audio frequency	1
(c) Telegraphy by the on-off keying of a modulating audio frequency or audio frequencies, or by the on-off keying of the modulated emission (Special case: an unkeyed modulated emission.)	2
(d) Telephony (including sound broadcasting)	3
(e) Facsimile (with modulation of main carrier either directly or by frequency modulated subcarrier)	4
(f) Television (vision only)	5
(g) Four-frequency diplex telegraphy	6
(h) Multichannel voice-frequency telegraphy	7
(i) Cases not covered by the above	9

(3) SUPPLEMENTARY CHARACTERISTICS	
(a) Double sideband	(none)
(b) Single sideband	
– reduced carrier	A
– full carrier	H
– suppressed carrier	J
(c) Two independent sidebands	B
(d) Vestigial sideband	C
(e) Pulse	
– amplitude modulated	D
– width (or duration) modulated	E
– phase (or position) modulated	F
– code modulated	G

Classification of typical emissions:

Type of Modulation of Main Carrier	Type of Transmission	Supplementary Characteristics	Symbol
Amplitude Modulation	With no modulation	–	A0
	Telegraphy without the use of a modulating audio frequency (by on-off keying)	–	A1
	Telegraphy of the on-off keying of an amplitude-modulating audio frequency or audio frequencies, or by the on-off keying of the modulated emission (Special case: an unkeyed emission amplitude modulated.)	–	A2
	Telephony	Double sideband	A3
		Single sideband, reduced carrier	A3A
		Single sideband, suppressed carrier	A3J
		Two independent sidebands	A3B
	Facsimile (with modulation of main carrier either directly or by a frequency modulated sub-carrier)	–	A4
		Single sideband, reduced carrier	A4A
	Television	Vestigial sideband	A5C
	Multichannel voice-frequency telegraphy	Single sideband, reduced carrier	A7A
	Cases not covered by the above, e.g. a combination of telephony and telegraphy	Two independent sidebands	A9B
Frequency (or phase) Modulation	Telegraphy of frequency shift keying without the use of a modulating audio frequency: one of two frequencies is emitted at any instant.		F1
	Telegraphy by the on-off keying of a frequency modulating audio frequency or by the on-off keying of a frequency modulated emission (Special case: an unkeyed emission, frequency modulated.)	–	F2
	Telephony	–	F3
	Facsimile by direct frequency modulation of the carrier	–	F4
	Television	–	F5
	Four-frequency diplex telegraphy	–	F6

Type of Modulation of Main Carrier	Type of Transmission	Supplementary Characteristics	Symbol
	Cases not covered by the above in which the main carrier is frequency modulated	–	F9
Pulse Modulation	A pulsed carrier without any modulation intended to carry information (e.g. radar)		P0
	Telegraphy by the on-off keying of a pulsed carrier without the use of a modulating audio frequency	–	P1D
	Telegraphy by the on-off keying of a modulating audio frequency or audio frequencies, or by the on-off keying of a modulated pulsed carrier (Special case: an unkeyed modulated pulsed carrier.)	Audio frequency or audio frequencies modulating the amplitude of the pulses	P2D
		Audio frequency or audio frequencies modulating the width (or duration) of the pulses	P2E
		Audio frequency or audio frequencies modulating phase (or position) of the pulses	P2F
Pulse Modulation	Telephony	Amplitude modulated pulses	P3D
		Width (or duration) modulated pulses	P3E
		Phase (or position) modulated pulses	P3F
		Code modulated pulses (after sampling and quantization)	P3G
	Cases not covered by the above in which the main carrier is pulse modulated		P9

Designations provided above are prescribed by the International Telecommunications Union (ITU).

An emission designator consists of four parts:

(1) The bandwidth occupied, in kHz

(2) The type of modulation

(3) The type of transmission

(4) Supplementary characteristics

3A3A

Example: 3 – Bandwidth 3 kHz

A – Amplitude modulated

3 – Telephony

A – Reduced carrier

The following types of emission are representative of those now applicable to naval communications. These designators will be gradually introduced into the text of this publition as future changes are issued.

Designator	Type of Emission
1.5A2 – – –	Tone modulated RATT (60 WPM)
1.08F1 – –	60 WPM single channel RATT
0.1A1 – – –	CW telegraph at 25 WPM
2.04A2 – –	CW telegraph tone modulated 1020 cycle tone
6A3 – – –	AM telephony
0.6F1 – – –	RATT (below 550 kHz)
1.24F1 – –	100 WPM 2-channel RATT (2000-30,000 kHz)
1.31F1 – –	120 WPM 2-channel RATT (2000-30,000 kHz)
2.85F1 – –	4-channel MUX
4F4 – – –	Facsimile
36F3 – – –	FM telephony

Designator	Description
12A9B – –	Formerly 12A9c. Four 3 kHz intelligence channels, any intelligence channel suitable for multi-channel RATT or one voice channel. The suppressed carrier is the same as the assigned frequency.
9A9B – – –	Formerly 9A9c. Three 3 kHz intelligence channels, used interchangeably for voice and/or RATT. The suppressed carrier is 1.5 kHz above or below the assigned frequency.
6A9B – – –	Formerly 6A9c. Two 3 kHz intelligence channels, used interchanbeably for voice and/or RATT. The suppressed carrier is the same as the assigned frequency.
6A9J – – –	Formerly 6A9c. Two 3 kHz intelligence channels, used interchangeably for voice and/or RATT. The suppressed carrier is 3 kHz above or below the assigned frequency.
3A7J – – –	Formerly 3A9c. A single 3 kHz intelligence channel authorized for multi-channel RATT. The suppressed carrier is 1.5 kHz above or below the assigned frequency.
3A3J – – –	Formerly 3A9C or 3A3a. A single 3 kHz intelligence channel authorized for voice transmission. The suppressed carrier is 1.5 kHz above or below the assigned frequency.
3A9A – – –	A single 3 kHz intelligence channel authorized for the transmission of complex signals employing kineplex, phase multi-locking, or such other techniques that may be developed in the future. The reduced carrier is 1.5 kHz above or below the assigned frequency.

NOTE: OPNAVINST 02030.2 contains amplifying information concerning the use and designation of sideband channels. When the carrier frequency is other than the assigned frequency (center of the occupied band), it will be shown in parentheses after the assignment.

5. ACRONYMS AND ABBREVIATIONS

AAV	Airborne Assault Vehicle
AC	Alternating Current
ACNO	Assistant Chief of Naval Operations
ADO	Advanced Development Objective
ADP	Automatic Data Processing
ADPE	Automatic Data Processing Equipment
AEC	Atomic Energy Commission
AFCEA	Armed Forces Communications and Electronics Association
AGE	Aerospace Ground Equipment
ALGOL	Algorithmic Language
AM	Amplitude Modulation
AMC	Army Materiel Command
AO	Administrative Office, Navy Department
APL	Applied Physics Laboratory
APP	Advanced Procurement Plan
ARPA	Advanced Research Projects Agency
ARPN	Aircraft and Related Procurement (Navy)
ASAP	As Soon as Possible
ASD	Assistant Secretary of Defense
ASL	Applied Scientific Laboratory
ASN (I&L)	Assistant Secretary of the Navy (Installations and Logistics)
ASN (R&D)	Assistant Secretary of the Navy (Research and Development)
ASPPO	Armed Services Procurement Planning Officer
ASPR	Armed Services Procedurement Regulation
ASW	Anti-Submarine Warfare
ATDS	Airborne Tactical Data System
BA	Budget Activity
BIS	Board of Inspection and Survey
BITE	Built-In Test Equipment
BNEP	Basic Naval Establishment Plan
BOB	Bureau of the Budget
BRA	Bench Replaceable Assembly
BuMed	Bureau of Medicine and Surgery
BuPers	Bureau of Naval Personnel
BW	Bandwidth
CAB	CNO Advisory Board
CAO	Collateral Action Office
CCIR	International Radio Consultative Committee
CD	Contract Definition
CDC	Combat Developments Command
CF	Concept Formulation
CFE	Contractor Furnished Equipment
CHINFO	Chief of Naval Information
CIP	Class Improvement Plan

CISPR	International Special Committee on Radio Interference
CINCEUR	Commander in Chief, Europe
CINCPAC	Commander in Chief, Pacific
CMC	Commandant, Marine Corps
CNA	Center for Naval Analyses
CND	Chief of Naval Development
CNM	Chief of Naval Material
CNO	Chief of Naval Operations
CNP	Chief of Naval Personnel
CNR	Chief of Naval Research
CO	Contract Officer
COBOL	Common Business Oriented Language
COMOPTEVFOR	Commander, Operational Test and Evaluation Force
COOPLANS	Continuity of Operations Plans
COTR	Contract Officer Technical Representative
CPFF	Cost Fixed Fee Contracts
CSR	Contract Status Report
CTS	Contractor Technical Service
DASA	Defense Atomic Support Agency
DC	Direct Current
DCA	Defense Communication Agency
DCAA	Defense Contract Audit Agency
DCAS	Defense Contract Administration Services (DSA)
DCASR	Defense Contract Administration Services Region
DCNM (P&FM)	Deputy Chief of Naval Material (Programs and Financial Management)
DCNM (D)	Deputy Chief of Naval Material (Development)
DCNM (M&F)	Deputy Chief of Naval Material (Material and Facilities)
DCNO (P&R)	Deputy Chief of Naval Operations (Personnel and Naval Reserve) (OP-01)
DCNO (R)	Deputy Chief of Naval Operations (Readiness) (OP-03)
DCNO (AIR)	Deputy Chief of Naval Operations (Air) (OP-05)
DCNO (L)	Deputy Chief of Naval Operations (Logistics)
DCNO (P&P)	Deputy Chief of Naval Operations (Plans and Policy) (OP-06)
DCNO (D)	Deputy Chief of Naval Operations (Development) (OP-07)
DCP	Development Concept Paper
DCRP	Disaster Control Recovery Plans
DCS	Defense Communications System
DD 1498	DOD Research and Technology Resume
DDC	Defense Documentation Center
DDR&E	Director of Defense Research and Engineering
D&F	Determination and Finding
DGM	Defense Guidance Memorandum
DIA	Defense Intelligence Agency
DLP	Directory of Laboratory Programs
DMSO	Divisions and Major Staff Offices
DNC	Director Naval Communications

DNFYP	Department of the Navy Five-Year Program
DNL	Director of Naval Laboratories
DNPP	Director, Naval Program Planning
DNPR	Director, Naval Petroleum Reserves
DOD	Department of Defense
DPM	Draft Presidential Memorandum
DSA	Defense Supply Agency
DSB	Defense Science Board
ECAC	Electromagnetic Compatibility Analysis Center
ECP	Engineering Change Proposal
EDG	Exploratory Development Goals
EDR	Exploratory Development Requirement
EHF	Extremely High Frequency
EIA	Electronic Industries Association
ELF	Extremely Low Frequency
EM	Electromagnetic
EMC	Electromagnetic Compatibility
EMCAB	Electromagnetic Compatibility Advisory Board
EMCP	Electromagnetic Compatibility Program
EME	Electromagnetic Emission
EMF	Electromotive Force (electric potential)
EMI	Electromagnetic Interference
EMS	Electromagnetic Susceptibility
FAAB	Frequency Allocation Advisory Board
FAC	Fleet Activities Command
FCC	Federal Communications Commission
FDGM	Final Defense Guidance Memorandum
FIP	Fleet Introduction Program
FM	Frequency Modulation
FMF	Fleet Marine Force
FORTRAN	Formula Translation
FPF	Fixed-Price-Firm Contract
FPE	Fixed-Price-Escalation Contract
FPR	Fixed-Price-Redeterminable
FPI	Fixed-Price-Incentive Contract
FR/IED	Foundation Research/Independent
FY	Fiscal Year
FYDP	Five-Year Defense Program
GAO	General Accounting Office
GFE	Government Furnished Equipment
GO5	General Order Number 5
GOR	General Operational Requirement
HERO	Hazard of Electromagnetic Radiation to Ordnance
HF	High Frequency
HRA	Hard Replaceable Assembly
IBOP	International Balance of Payments

IBW	Impulse Bandwidth
IDA	Institute of Defense Analysis
IDGM	Initial Defense Guidance Memorandum
IEEE	Institute of Electrical and Electronics Engineers
IF	Intermediate Frequency
IFRB	International Frequency Registration Board
ILCEP	Independent Laboratory Committee on Editing and Publishing
ILS	Integrated Logistic System
IRAC	Interdepartmental Radio Advisory Committee
ISM	Industrial, Scientific, Medical
ITU	International Telecommunication Union
JAG	Judge Advocate General (Office of)
JCS	Joint Chiefs of Staff
JIEP	Joint Intelligence Estimate for Planning
JLRSS	Joint Long-Range Strategic Study
JRDOD	Joint Research and Development Objectives Document
JRDP	Joint Research and Development Plan
JSCP	Joint Strategic Capabilities Plan
JSOP	Joint Strategic Objectives Plan
JTAC	Joint Technical Advisory Council
LF	Low Frequency
LO	Local Oscillator
LRA	Light Replaceable Assembly
MAAG	Military Assistance Advisory Group
MCL	Master Configuration List
MC,N	Military Construction, Navy
MCON	Military Construction
MF	Medium Frequency
MFI	Major Force Issue
MIC	Management Information Center
MIG	Metal-Inert-Gas (arc welding)
MILCON	Military Construction
MILSTRIP	Military Standard Requisitioning and Issue Procedure
MIPR	Military Interdepartmental Procurement Requests
MIS	Material Inspection Service
MLC	Military Liaison Committee
MMROP	Marine Corps Mid-Range Objectives Plans
MOBCON	Mobilization Construction Plan
MP,MC	Military Personnel, Marine Corps
MP,N	Military Personnel, Navy
MRO	Mid-Range Objectives
MSTS	Military Sea Transportation Service
MTBF	Mean Time Between Failures
MTDS	Marine Tactical Data System
NADC	Naval Air Development Center
NAEC	Naval Air Engineering Center

NAIR	Naval Air Systems Command Headquarters
NARAD	Navy Research and Development Briefing Report (from CNR)
NARDIS	Navy Automated Research and Development Information System
NARF	Naval Aerospace Recovery Facility
NARF	Naval Arctic Research Facility
NASA	National Aeronautics and Space Administration
NASL	Naval Applied Science Laboratory
NATC	Naval Air Test Center
NATF (SI)	Naval Test Facility (Ship Installations)
NATTS	Naval Air Turbine Test Station
NAVAIR	Naval Air Systems Command
NAVCOMPT	Office of the Comptroller of the Navy
NAVCOSSACT	Navy Command Systems Support Activity
NAVELEX	Naval Electronic Systems Command
NAVEXOS	Executive Office of the Secretary, Department of the Navy
NAVFAC	Naval Facilities Engineering Command
NAVMAT	Naval Material Command
NAVORD	Naval Ordnance Systems Command
NAVPECO	Navy Production Equipment Control Office
NAVPEP	Navy Program Evaluation Procedures
NAVSEC	Naval Ships Engineering Center
NAVSHIPS	Naval Ship Systems Command
NAVSTRIP	Navy Standard Requisitioning and Issue Procedure
NAVSUP	Navy Supply Systems Command
NAVSYSCOM	Naval Systems Commands
NAVWAG	Naval Warfare Analyses Group
NBL	Naval Biological Laboratory
NCEL	Naval Civil Engineering Laboratory
NCIS	Navy Cost Information System
NCP	Navy Capabilities Plan
NDPIC	Navy Department Program Information Center
NEL	Navy Electronics Laboratory
NELC	Naval Electronics Laboratory Center
NEODF	Navy Explosive Ordnance Disposal Facility
NESTEF	Naval Electronic Systems Test and Evaluation Facility
NIF	Navy Industrial Fund
NLCP	Navy Logistics Capabilities Plan
NLRG	Navy Long-Range Guidance
NMC	Naval Material Command
NMDL	Navy Mine Defense Laboratory
NMRG	Navy Mid-Range Guidance
NMS	Navy Mid-Range Study
NOA	New Obligational Authority
NOL	Naval Ordnance Laboratory
NOTS	Naval Ordnance Test Station
NOU	Naval Ordnance Unit

NPE	Navy Preliminary Evaluation
NPPO	Navy Program Planning Office
NPPC	CNO Program Planning Council
NPPR	Navy Program Progress Report
NPPS	Navy Publications and Printing Service
NRAC	Naval Research Advisory Committee
NRDL	Naval Radiological Defense Laboratory
NRL	Naval Research Laboratory
NRR	Navy Research Requirements
NSRDC	Naval Ship Research and Development Center
NSA	National Security Agency
NSC	National Security Council
NSF	National Science Foundation
NSP	Navy Support Plan
NSS	Navy Strategic Study
NTDS	Naval Tactical Data System
NUSL	Navy Underwater Sound Laboratory
NUWRES	Naval Underwater Weapons Research and Engineering Station
NWEF	Naval Weapons Evaluation Facility
NWL	Naval Weapons Laboratory
NWSA	Naval Weapons Support Activity
OASD ( )	Office of the Assistant Secretary of Defense (C) Comptroller (I&L) Installations & Logistics (SA) Systems Analysis
OEM	Original Equipment Manufacturer
OLA	Office of Legislative Affairs
OMI	Office of Management Information
O&M, MC	Operations & Maintenance, Marine Corps
O&M, N	Operations & Maintenance, Navy
ONM	Office of Naval Material
ONR	Office of Naval Research
OPA	Office of Program Appraisal
OPEVAL	Operational Evaluation
OP, N	Other Procurement, Navy
OPNAV	Office of the Chief of Naval Operations
OPTEVFOR	Operational Test and Evaluation Force
OSD	Office of Secretary of Defense
OSIP	Operational Suitability Improvement Program (for aircraft)
OTP	Office of Telecommunications Policy
PAM	Pulse Amplitude Modulation
PAM N	Procurement Aircraft and Missiles, Navy
PAO	Primary Action Officer
PBD	Program Budget Decision
PCCS	Program Change Control Systems
PCD	Program Change Decision

PCM	Pulse-Code Modulation
PCR	Program Change Request
PDM	Pulse-Duration Modulation
PE	Program Element
PERT	Program Evaluation and Review Technique
PESD	Program Elements Summary Data Sheet
PJ	Procurement Justification
PM	Phase Modulation
P, MC	Procurement, Marine Corps
PMP	Program Management Plan Project Master Plan
PMR	Pacific Missile Range
PO	Program Objectives
POCP	Program Objectives Change Proposal
PO-FY	Program Objectives, Department of the Navy
PPM	Pulse-Position Modulation
PR	Procurement Request
PSAC	President's Scientific Advisory Committee
PTDP	Preliminary Technical Development Plan
PTM	Pulse-Time Modulation
QRA	Quick Replaceable Assembly
RADC	Rome Air Development Center
RADHAZ	Radiation Hazard
RAN	Request for Authority to Negotiate
R&D	Research and Development
RDT&E	Research, Development, Test and Evaluation
RDT&EN	Appropriation RDT&E Navy
RE	Radiated Emission
RF	Radio Frequency
RFI	Radio Frequency Interference
RFP	Request for Proposal
RIC	Resource Identification Code
RMS	Resource Management System
RP, MC	Reserve Personnel, Marine Corps
RPN	Reserve Personnel
SAE	Society of Automotive Engineers
SAPST	Special Assistant to President for Science and Technology
SASN	Special Assistant to the Secretary of the Navy
SCB	Ship Characteristics Board
SCN	Ships and Conversion, Navy
SECDEF	Secretary of Defense
SECNAV	Secretary of the Navy
SHF	Super-High Frequency
SNDL	Standard Navy Distribution List
SOR	Specific Operational Requirement
SP	Special Projects (Code or Office)

SRA	Shop Replaceable Assembly
SSB	Single-Sideband Modulation
STINFO	Scientific and Technical Information
TAB	Technical Abstract Bulletin
TDP	Technical Development Plan
TEM Wave	Transverse Electromagnetic Wave
TERAC	Tactical Electromagnetic Readiness Advisory Council
TE Wave	Transverse Electric Wave
TIG	Tungsten-Inert-Gas (arc welding)
TM Wave	Transverse Magnetic Wave
TOA	Total Obligational Authority
TPO	Tentative Program Objectives
TSOR	Tentative Specific Operational Requirement
TV	Television
UHF	Ultra-High Frequency
UIC	Unit Identifier Code
USN/USL	U. S. Navy Underwater Sound Laboratory
VHF	Very High Frequency
VLF	Very Low Frequency
VTOL	Vertical Take-Off and Landing
WGD	Working Group Director
WRA	Weapons Replaceable Assembly
WSEG	Weapons Systems Evaluation Group

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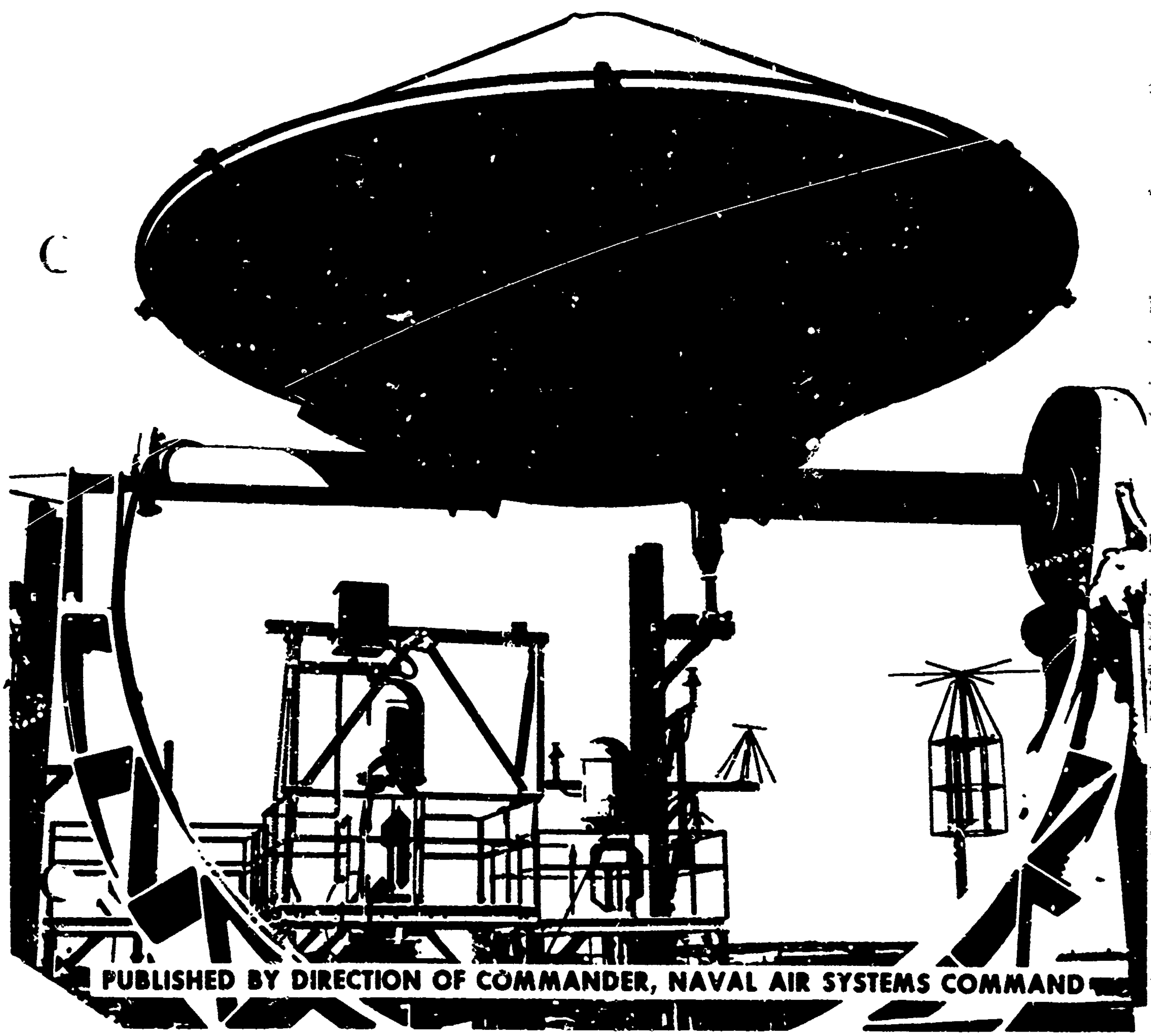
APPENDIX F

COMPUTATIONAL AIDS



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NAVAIR EMC MANUAL

APPENDIX F

COMPUTATIONAL AIDS

PREFACE

This appendix contains computational aids such as graphs, nomographs, and tables to assist EMC engineers and technicians in making necessary EMC measurements and analyses during the design and testing of electronic equipments and systems.

Users of this material are encouraged to submit recommendations for improving these computational aids and to submit new computational aids.

CONTENTS

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ILLUSTRATIONS

TABLES

SECTION I

CONVERSION OF dBm TO VOLTAGE ACROSS A SPECIFIED RESISTIVE LOAD

(See Figure 1 and Table 1)

1. The power expended in resistive loads in RF circuits such as a 50-ohm transmission line is commonly expressed in decibels relative to one milliwatt (dBm).

2. The sensitivity of a receiver may be expressed in microvolts, or microvolts may be specified or measured across a resistive load.

3. Using the nomograph of Figure 1, it is possible to determine any one of three parameters if the other two are known, dBm, voltage, or resistance across which the voltage appears.

4. The nomograph has three pairs of voltage and dBm scales. The corresponding pairs are indicated by the three connecting lines with arrowheads, two at the top and one at the bottom of the scales.

5. To use the nomograph, place a straightedge between the two known values on two of the scales and read the unknown value at the point where the straightedge crosses the third scale. The dashed line example can indicate any of three voltages and corresponding dBm power levels across a 50-ohm resistance, according to which voltage and power scales are used. The three possible values are:

   a. 0.1 volt/–7 dBm

   b. 10 microvolts/–87 dBm

   c. (0.1) microvolt/–127 dBm

6. Table 1 provides the relationship between power and voltage across a 50-ohm resistance, including decibels relative to one microvolt (dBμV).

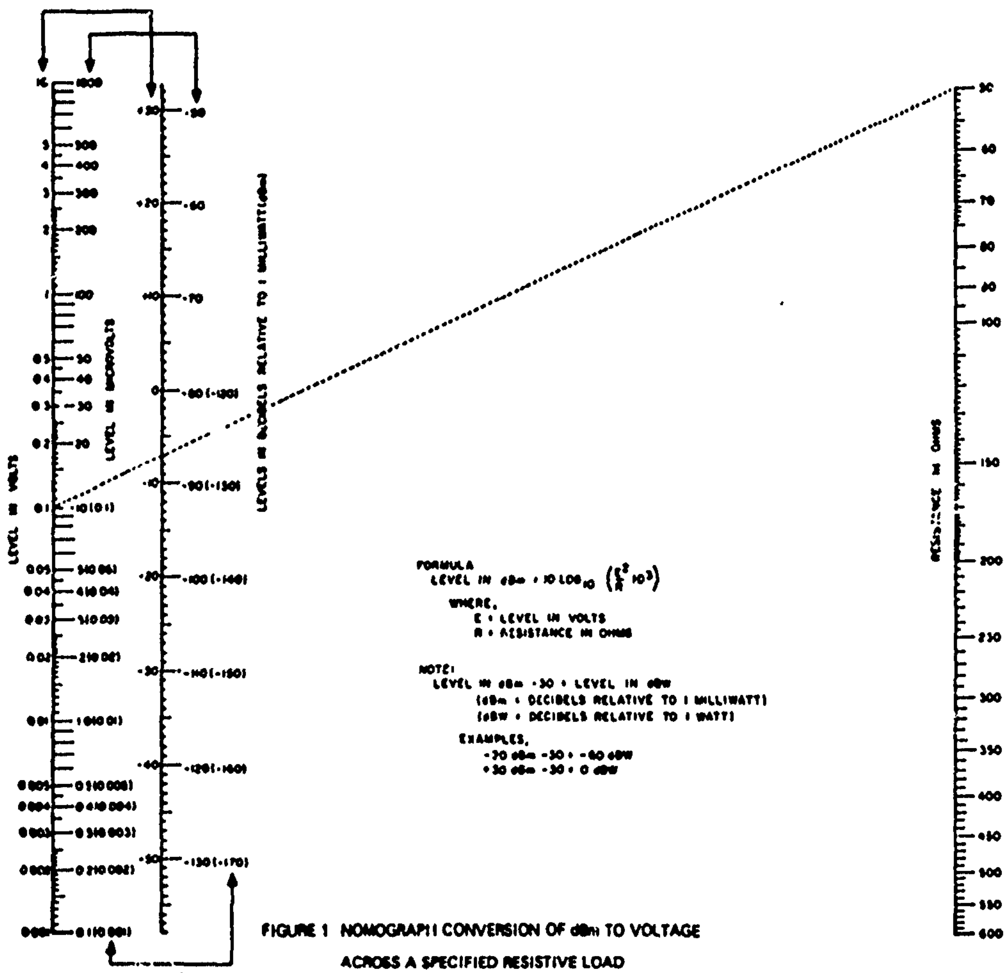


FIGURE 1 NOMOGRAPH CONVERSION OF dBm TO VOLTAGE ACROSS A SPECIFIED RESISTIVE LOAD

dBm	dBµV	Volts
+53	160	100
+48	155	56
+43	150	32
+38	145	18
+33	140	10
+28	135	5.6
+23	130	3.2
+18	125	1.8
+13	120	1.0
+ 8	115	.56
+ 3	110	.32
- 2	105	.18
- 7	100	.10
- 8	99	89 mV
- 9	98	79 mV
-10	97	71 mV
-11	96	63 mV
-12	95	56 mV
-13	94	50 mV
-14	93	45 mV
-15	92	40 mV
-16	91	35 mV
-17	90	32 mV
-18	89	28 mV
-19	88	25 mV
-20	87	22 mV
-21	86	20 mV
-22	85	18 mV
-23	84	16 mV
-24	83	14 mV
-25	82	13 mV
-26	81	11 mV
-27	80	10 mV
-28	79	8.9 mV
-29	78	7.9 mV
-30	77	7.1 mV
-31	76	6.3 mV
-32	75	5.6 mV
-33	74	5.0 mV
-34	73	4.5 mV
-35	72	4.0 mV
-36	71	3.5 mV
-37	70	3.2 mV
-38	69	2.8 mV
-39	68	2.5 mV
-40	67	2.2 mV
-41	66	2.0 mV
-42	65	1.8 mV
-43	64	1.6 mV
-44	63	1.4 mV
-45	62	1.3 mV
-46	61	1.1 mV
-47	60	1.0 mV
-48	59	.89 mV
-49	58	.79 mV
-50	57	.71 mV
-51	56	.63 mV
-52	55	.56 mV
-53	54	.50 mV
-54	53	.45 mV
-55	52	.40 mV
-56	51	.35 mV
-57	50	.32 mV
-58	49	.28 mV
-59	48	.25 mV
-60	47	.22 mV
-61	46	.20 mV
-62	45	.18 mV
-63	44	.16 mV
-64	43	.14 mV
-65	42	.13 mV
-66	41	.11 mV
-67	40	.10 mV

dBm	dBµV	Microvolts
- 68	39	89
- 69	38	79
- 70	37	71
- 71	36	63
- 72	35	56
- 73	34	50
- 74	33	45
- 75	32	40
- 76	31	35
- 77	30	32
- 78	29	28
- 79	28	25
- 80	27	22
- 81	26	20
- 82	25	18
- 83	24	16
- 84	23	14
- 85	22	13
- 86	21	11
- 87	20	10
- 88	19	8.9
- 89	18	7.9
- 90	17	7.1
- 91	16	6.3
- 92	15	5.6
- 93	14	5.0
- 94	13	4.5
- 95	12	4.0
- 96	11	3.5
- 97	10	3.2
- 98	9	2.8
- 99	8	2.5
-100	7	2.2
-101	6	2.0
-102	5	1.8
-103	4	1.6
-104	3	1.4
-105	2	1.3
-106	1	1.1
-107	0	1.0
-108	- 1	.89
-109	- 2	.79
-110	- 3	.71
-111	- 4	.63
-112	- 5	.56
-113	- 6	.50
-114	- 7	.45
-115	- 8	.40
-116	- 9	.35
-117	-10	.32
-118	-11	.28
-119	-12	.25
-120	-13	.22
-121	-14	.20
-122	-15	.18
-123	-16	.16
-124	-17	.14
-125	-18	.13
-126	-19	.11
-127	-20	.10
-132	-25	.056
-137	-30	.032
-142	-35	.018
-147	-40	.010
-152	-45	.006

TABLE 1 VOLTAGE/POWER RELATIONSHIPS ACROSS 50 OHMS

G_t = Gain of the transmitting antenna looking toward the receiving antenna (dB).

L_s = Transmission loss in free space (dB).

G_r = Gain of the receiving antenna looking toward the transmitting antenna (dB).

L_r = Loss in receiver antenna transmission line (dB).

P_r = Receiver input power in decibels relative to 1 watt (dBW).

Using the same values as in the previous example:

$$P_r = 26 - 1 + 4 - 30 + 3 - 2$$

$$= 0 \text{ dBW}$$

$$= 1 \text{ W}$$

SECTION II

TRANSMISSION LOSS IN FREE SPACE (ISOTROPIC ANTENNAS AT BOTH TERMINALS)

(See Figures 2 and 3)

1. The coupling factor between a transmitter and a receiver is a function of several parameters:
   a. Frequency
   b. Separation distance between antennas
   c. Gain (relative to isotropic) of transmitting antenna, in the direction of the transmitting antenna.
   d. Gain (relative to isotropic) of receiving antenna, in the direction of the transmitting antenna.
   e. Loss in transmitter antenna transmission line.
   f. Loss in receiver antenna transmission line.

2. Figures 2 and 3 permit the effect of two of these parameters, frequency and separation distance, to be determined. The sample dashed line of the nomograph of Figure 2 indicates a transmission loss of 30 dB between two antennas separated by 100 feet, at an operating frequency of 25 MHz. (Figure 3 indicates this loss would increase to about 70 dB when the distance is increased to two miles.)

3. Assuming the following for the above conditions of 25 MHz and a 100-foot separation:
   a. The loss in transmitter antenna transmission lines is 1 dB.
   b. The gain of the transmitting antenna (relative to an isotropic antenna) looking toward the receiving antenna is 4 dB.
   c. The transmission loss in free space (from Figure 2) is 30 dB.
   d. The gain of the receiving antenna (relative to an isotropic antenna) looking toward the transmitting antenna is 3 dB.
   e. The loss in the receiver antenna transmission line is 2 dB.

Then the coupling factor between transmitter output terminals and receiver input terminals would be −1 dB +4 dB −30 dB +3 dB −2 dB = −26 dB. This means that the power at the receiver input terminals would be 26 dB below the power at the transmitter output terminals. Thus if the transmitter power output was 400 W, the power at the receiver input terminals would be 1 W.

The received power may be found by expressing the previous reasoning as an equation:

$$P_r = P_t - L_t + G_t - L_s + G_r - L_r$$

where

P_t = Transmitter output power in decibels relative to 1 watt (dBW).

L_t = Loss in transmitter antenna transmission line (dB).

G_t = Gain of the transmitting antenna looking toward the receiving antenna (dB).

L_s = Transmission loss in free space (dB).

G_r = Gain of the receiving antenna looking toward the transmitting antenna (dB).

L_r = Loss in receiver antenna transmission line (dB).

P_r = Receiver input power in decibels relative to 1 watt (dBW).

Using the same values as in the previous example:

$$P_r = 26 - 1 + 4 - 30 + 3 - 2$$

$$= 0 \text{ dBW}$$

$$= 1 \text{ W}$$

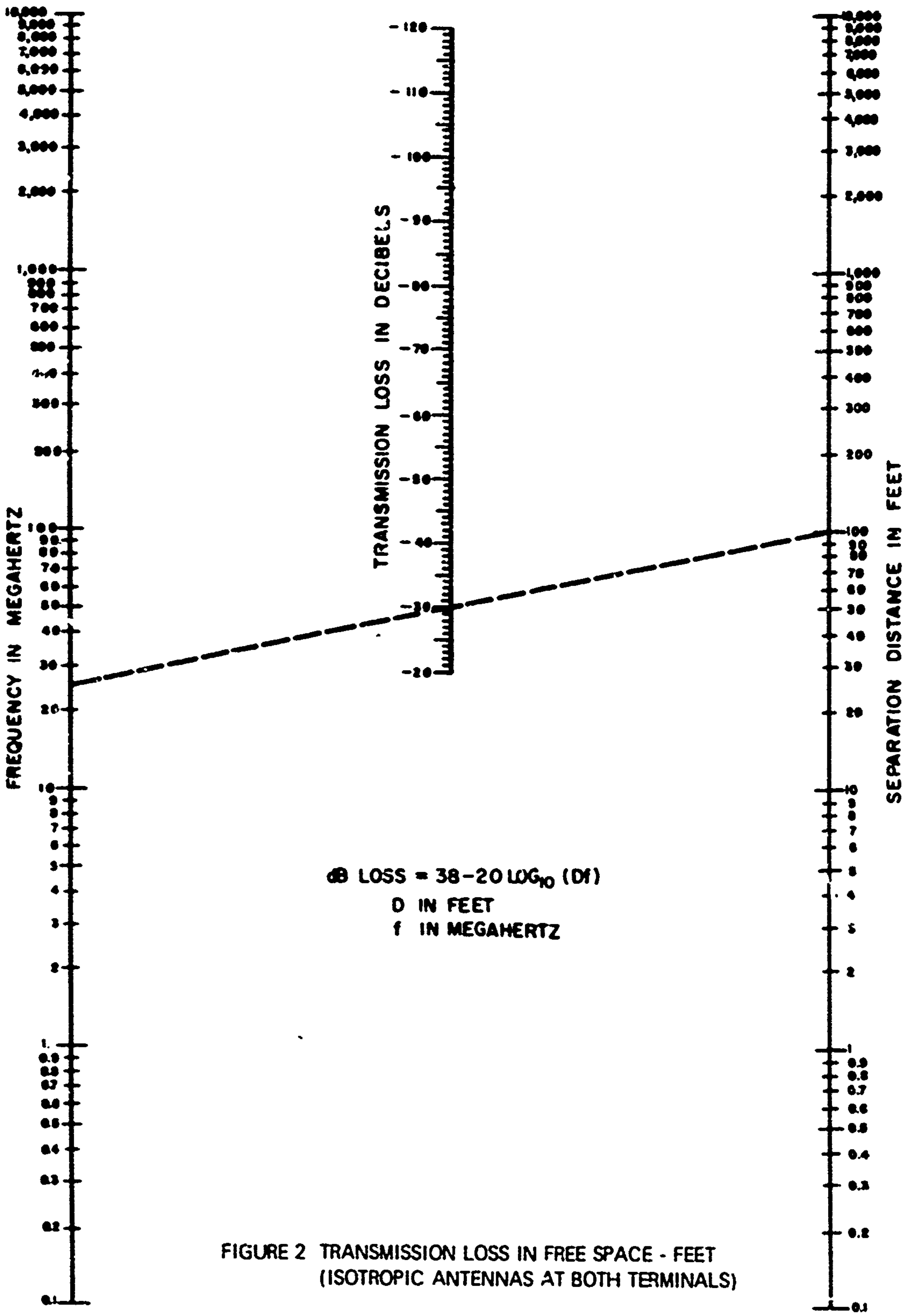


FIGURE 2 TRANSMISSION LOSS IN FREE SPACE - FEET
(ISOTROPIC ANTENNAS AT BOTH TERMINALS)

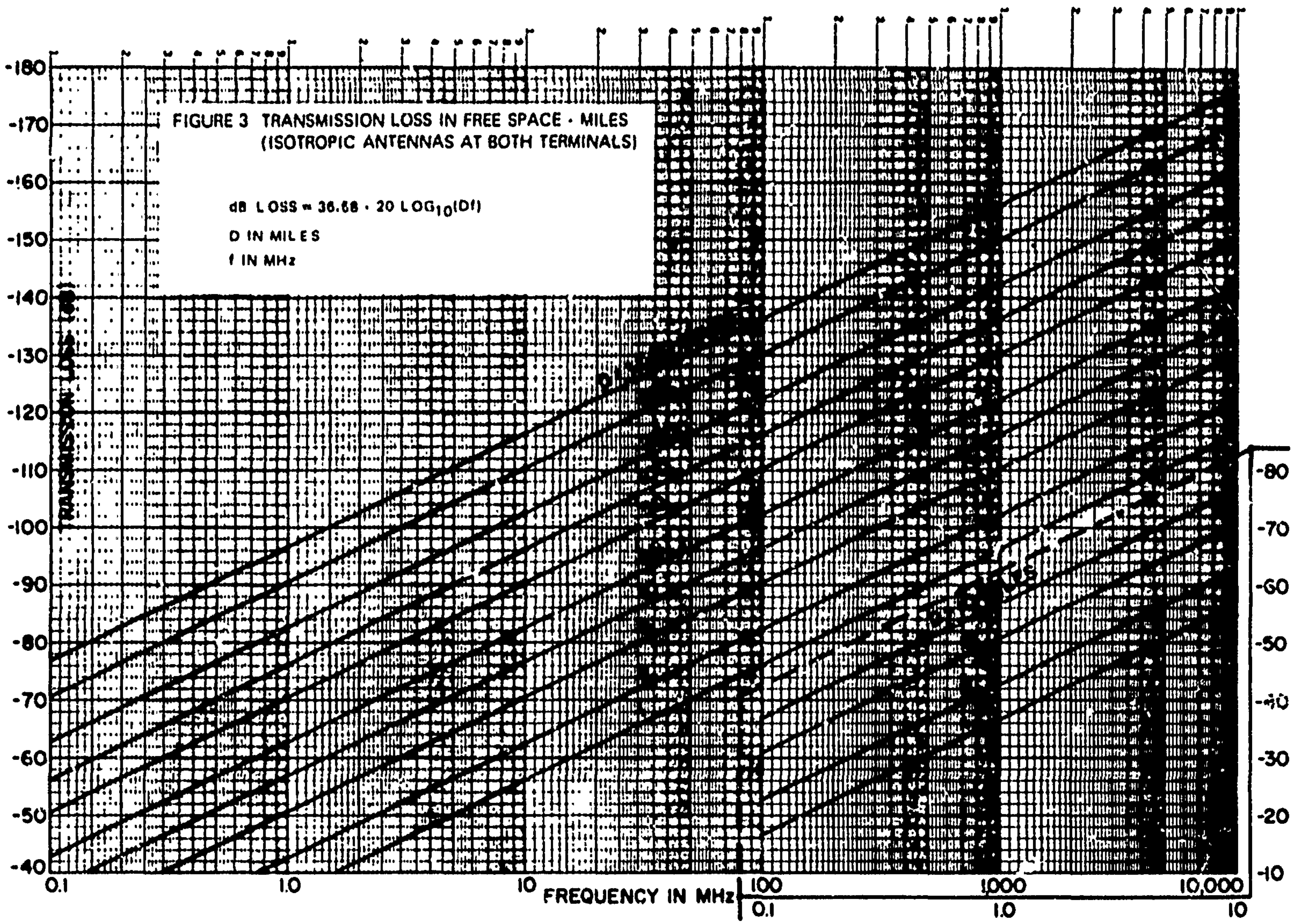


FIGURE 3 TRANSMISSION LOSS IN FREE SPACE - MILES (ISOTROPIC ANTENNAS AT BOTH TERMINALS)

SECTION III

CONVERSION OF POWER DENSITY TO FIELD STRENGTH
(See Figure 4)

1. The magnitude of an electromagnetic field may be expressed in terms of its field strength in microvolts per meter (μV/M) or in terms of its power density in any of three common units of measure, milliwatts per square centimeter (mW/CM^2), decibels relative to one milliwatt per square meter (dBm/M^2), and decibels relative to the power density at one microvolt per meter field strength (dBμV/M)

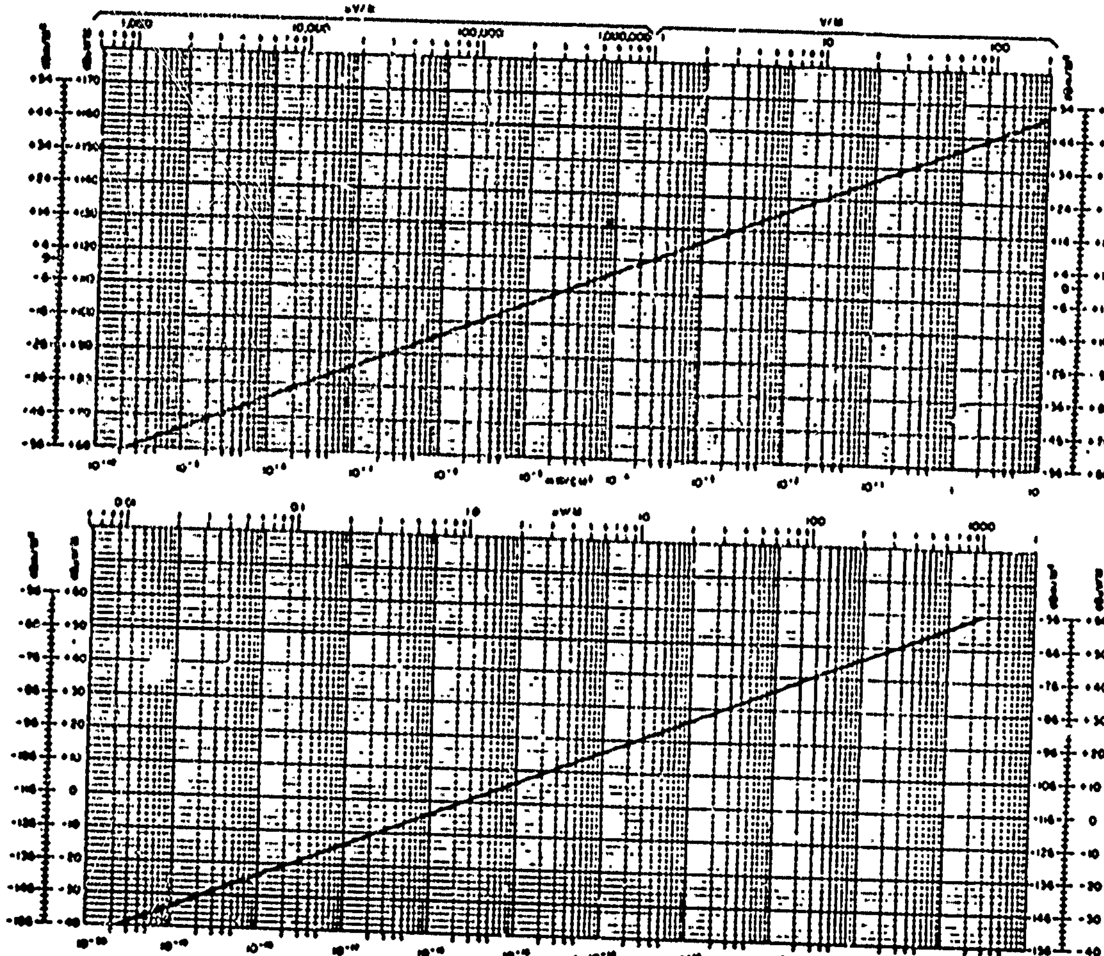
2. Unfortunately any of the four terms may be used, depending on what instrumentation was used in measuring or what equation or what graph was used to obtain the measurements. For example, at frequencies above about one gigahertz, where a horn antenna and a power meter are used in measuring, the magnitude will usually be read in mW/CM^2. At lower frequencies, using a dipole or rod antenna with a field intensity meter, the magnitude may be read in (μV/M). If these measurements are to be checked against the limits shown graphically in MIL-STD-461, they may have to be converted to (dBμV/M).

3. Using the graph and scales of Figure 4, any one of the four units of measure may be converted to any one of the other three.

4. In the bottom scale of Figure 4, power density is expressed in milliwatts per square centimeter (mW/CM^2). If it is necessary to work with watts per square meter (W/M^2), the equation for converting between these two units (with examples) is shown in the block on Figure 4.

CAUTION

Field strength or power density measurements made in the Fresnel region may give erroneous values when Figure 4 is used to convert from field strength to power density or vice versa. This condition frequently occurs when measurements are made in a shielded enclosure or other limited measurement space.



WM = FIELD STRENGTH IN VOLTS PER METER

μV/M = FIELD STRENGTH IN MICROVOLTS PER METER

dBμV/M = POWER DENSITY IN DECIBELS RELATIVE TO THE POWER DENSITY AT ONE MICROVOLT PER METER FIELD STRENGTH

dBm/M² = POWER DENSITY IN DECIBELS RELATIVE TO ONE MILLIWATT PER SQUARE METER

W/M² = POWER DENSITY IN WATTS PER SQUARE METER

mW/CM² = POWER DENSITY IN MILLIWATTS PER SQUARE CENTIMETER

LOG = LOG TO THE BASE 10

dBμV/M = 20 LOG (μV/M)

dBm/M² = 20 LOG (μV/M) − 116

dBm/M² = (dBμV/M) − 116

W/M² = $LOG^{-1} \frac{20 LOG(\mu V/M) - 146}{10}$

= $LOG^{-1} \frac{(dB\mu V/M) - 146}{10}$

CONVERTING WATTS PER SQUARE METER (W/M²) TO MILLIWATTS PER SQUARE CENTIMETER (mW/CM²)
mW/CM² = (W/M²) × 10^{-1}
EXAMPLES
10 W/M² = 1 mW/CM²
4×10^{-9} W/M² = 4×10^{-10} mW/CM²

FIGURE 4 CONVERSION OF POWER DENSITY TO FIELD STRENGTH (mW/CM², dBm/M², dBμV/M, μV/M)

SECTION IV

CONVERSION OF WATTS TO dBm

(See Figure 4)

1. Power may be expressed in watts (W) or in decibels relative to one milliwatt (dBm). For example, 1 watt (1,000 milliwatts) may be expressed as 30 dBm ($10 \log_{10} 1{,}000$).

2. Since both of these units of power are commonly used, Figure 5 is provided to convert from watts to dBm, or vice versa.

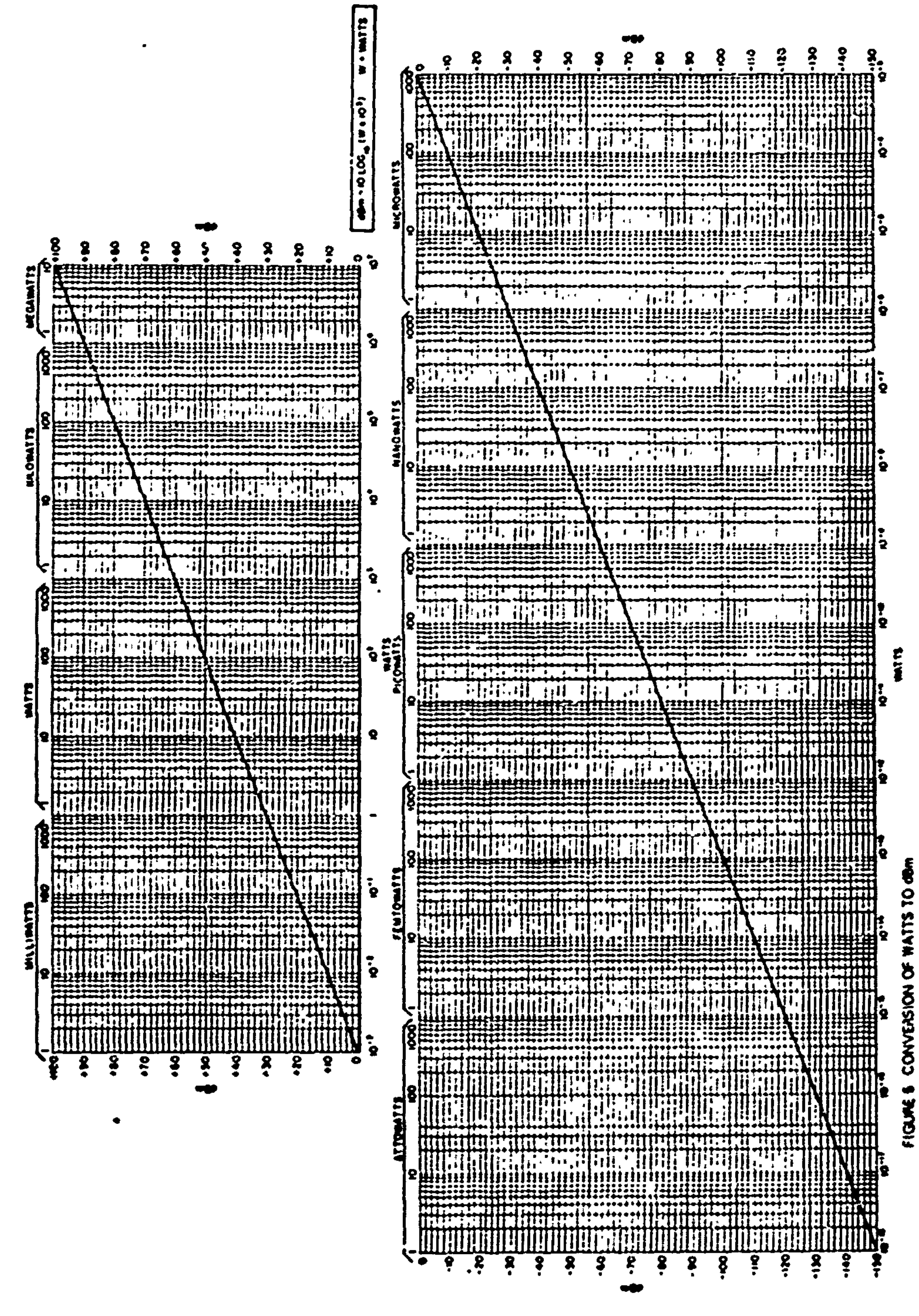


FIGURE 8 CONVERSION OF WATTS TO dBm

F-15

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(3) Using this number without the power of ten (1.55 in the example) enter the bottom scale of the vernier graph and read the value of X in dB from the left-hand scale (1.9 dB in the example). The answer is then 10 + 1.9, or 11.9 dB.

b. To convert from dB to power ratio:

(1) Locate the dB value on the left-hand scale of the main graph (11.9 dB in the example) and determine the power of ten from the bottom scale (10^1 in the example).

(2) Subtract from the dB value whatever multiple of 10 dB is necessary in order to have a dB value of less than ten (11.9 - 10 = 1.9 dB in the example).

(3) Using the dB value of less than ten (1.9 dB in the example) enter the left-hand scale of the vernier graph and obtain the significant figures of the power ratio from the bottom scale (1.55 in the example). The power ratio is then $1.55 \times 10^1 = 15.5$.

5. If any values of dB or power ratio are to be found that are outside the values given in the main graph of Figure 6, little trouble is involved if the relationship of dB and power of ten of the power ratio is noted, namely that the dB is ten times the power of ten of the power ratio.

Examples:
Given 127 dB, what is the corresponding power ratio?

a. 127 dB - 120 dB = 7 dB

b. Using 7 dB in the vernier graph gives the significant figure of 5 for the power ratio.

c. The 120 dB reveals that the power of ten of the power ratio is 120/10 = 12.

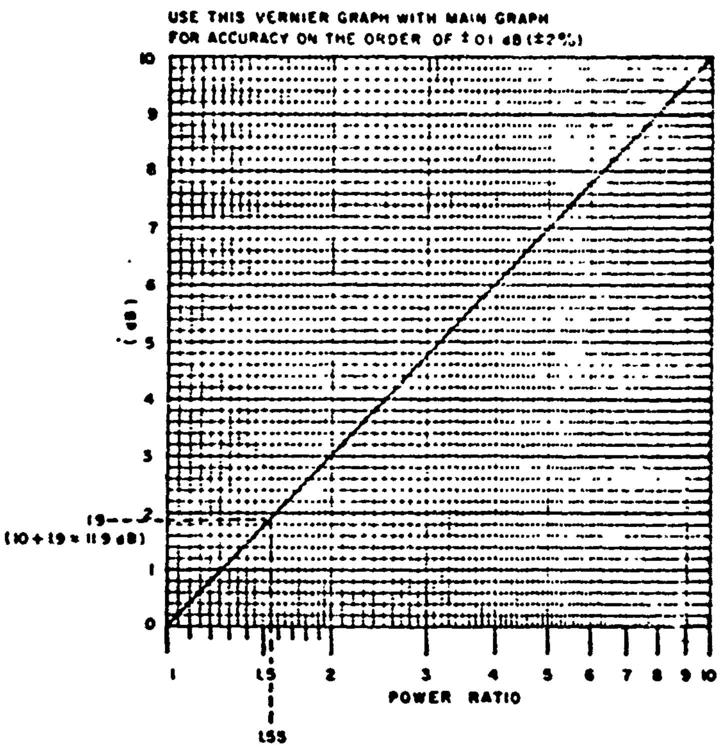
d. The answer is thus a power ratio of 5×10^{12}.

Given a power ratio of 4×10^8, what is the corresponding dB value?

a. The power of ten is 8, ten times this (10×8) gives a partial dB value of 80.

b. Using the power ratio of 4 in the vernier graph gives an additional value of 6 dB.

c. The answer is then 80 dB + 6 dB = 86 dB.



POWER RATIO = (VOLTAGE RATIO)^2

VOLTAGE RATIO = POWER RATIO

dB = 10 LOG_{10} (POWER RATIO)

dB = 20 LOG_{10} (VOLTAGE RATIO)

CONVERSION OF dB TO VOLTAGE RATIO

1. TO CONVERT FROM dB TO VOLTAGE RATIO ·
   - a DEVIDE dB BY 2
   - b PROCEED TO USE GRAPHS THE SAME AS WHEN FINDING POWER RATIO

   (EXAMPLE: [illegible])

2. TO CONVERT FROM VOLTAGE RATIO TO dB
   - a USE VOLTAGE RATIO AS POWER RATIO AND FIND dB FROM GRAPHS
   - b DOUBLE THE VALUE OF dB FOUND

   (EXAMPLE [illegible])

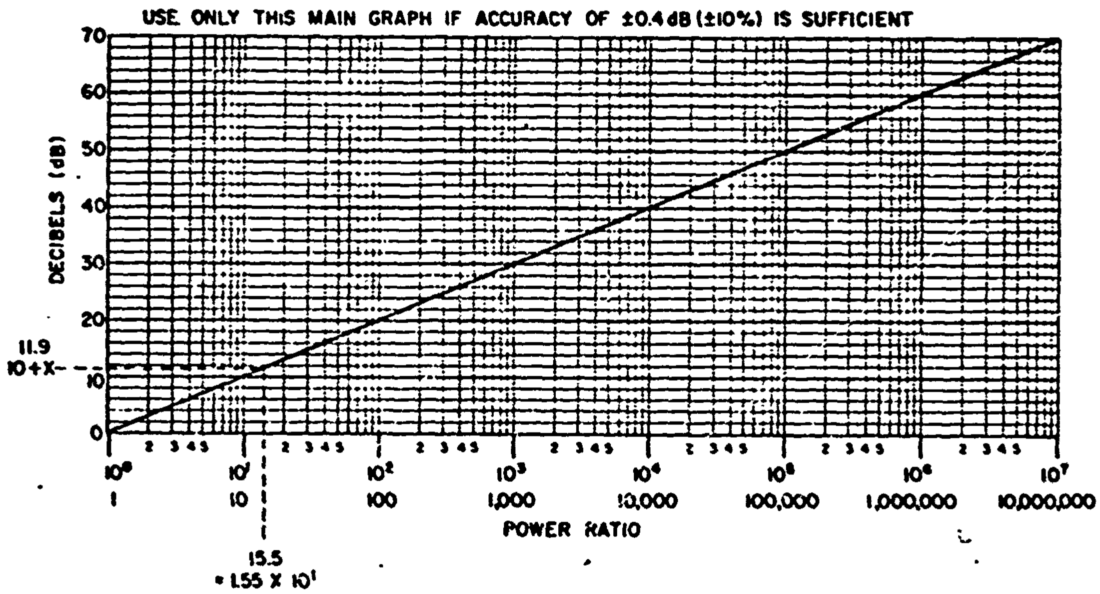


FIGURE 6 CONVERSION OF DECIBELS (dB) TO POWER RATIO OR VOLTAGE RATIO

Fig

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APPENDIX G

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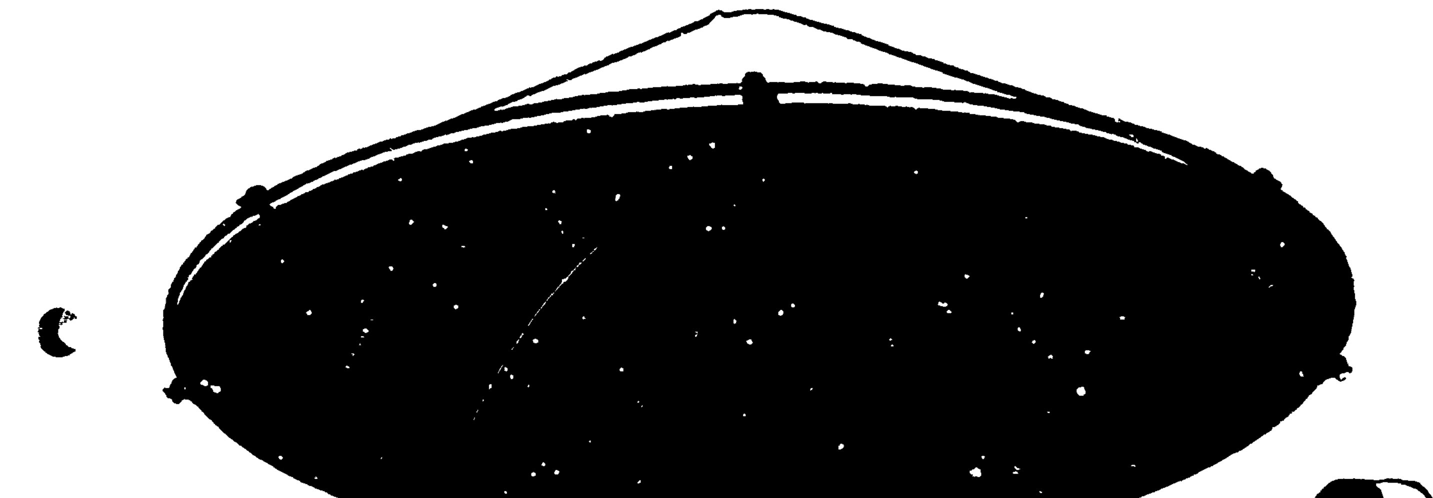

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APPENDIX G

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